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RETURNS FOR ELECTRIC TRACTION.

THE Joint Committee on Electric Powers (Protective Clauses) have agreed upon a clause to be inserted in all Bills and provisional orders, authorising the use of large electric currents otherwise than for electric lighting.

The clause enacts by the first sub-section that either insulated returns or uninsulated metallic returns of low resistance shall be used, and in the second sub-section, that all reasonable precautions shall be taken in construction and working, so as not injuriously to affect any gas, water, or other metallic pipes. The third sub-section requires compliance with any order which the Board of Trade may make for regulating the employment of insulated returns or of uninsulated metallic returns of low resistance for preventing injurious action on pipes; and for minimising, as far as is reasonably practicable, injurious interference with electric lines of other parties, and the currents therein, whether such lines are metallic or earth return. The fourth sub-section provides penalty for non-compliance with the Board's regulations.

The fifth sub-section applies to electric lines what the second sub-section applies to pipes in ensuring that all reasonable and proper precautions shall be taken in the construction and maintenance of the circuits and works, so as not to interfere injuriously with other circuits or the currents in such circuits. These precautions will be held to have been taken, so long as insulated returns, or uninsulated metallic returns of low resistance are used, and the directions of the Board of Trade complied with. In giving its directions the Board is instructed to have regard to the expense involved and its effect upon the commercial prospects of the undertaking.

A further provision is that at the expiration of a number of years nothing in this sub-section shall give any right of action in respect of, or to protect any electric lines or the currents therein, unless an insulated return is used on such circuits, and proper precautions taken to prevent injurious interference by or from other electric currents. Any differences arising from this sub-section are to be determined by the Board of Trade, or an arbitrator appointed by them.

In addition to defining a clause, the committee "have agreed upon" certain "resolutions, in the nature of recommendations." (They are also in the nature of reasons for the decisions arrived at.) The sixth resolution recommends that statutory powers be granted, enabling telephone lines to be laid underground, and the eighth defines some of the points to be considered in the Board of Trade's regulations, and the tenth resolution expresses the view of the committee, that proposed users of large currents should be required to give two years' notice to users of small currents, to enable them to protect themselves by insulation.

It will be seen that the Committee have steered a middle course. On the one hand they were asked to compel the use

of an insulated return; on the other hand they were asked to permit an uninsulated return. They concluded that in the present state of electrical science it was not to the public interest to insist on an insulated return, and they therefore permit an uninsulated metallic return, with the important addition of "low resistance." As most Acts of Parliament are expected to have loopholes through which a coach and four might be driven, the adoption of such comparative language as "low resistance" suggests the possibility of varied views on an important point.

But sub-section (*a*) of the 8th Resolution puts the case out of the range of individual opinion, and recommends that the regulations of the Board of Trade shall provide "that a return conductor, if in contact with the ground, shall be of such section and resistance as to have no difference of potential sufficient to set up injurious leakage currents in the earth." This provision sufficiently defines the "low resistance," and leaves to the Board of Trade the pleasant duty of answering, on some future occasions, the interesting question: What is an "injurious leakage current?" The Board of Trade sought the assistance of the Joint Committee to settle the clauses, and the Committee have handed back to the Board a great deal of the responsibility. That is at it should be. The Committee can now determine a line of action, but cannot foresee the changes due to practice and advances in science. In its regulations made from time to time the Board of Trade can have regard to both.

It seems to us that the committee's decisions are fair and reasonable. Pursuing the analogy which we raised in our issue of May 26th, the Committee have decided that the electrical earth is common land, which must be used by all, with due regard to the reasonable rights of others. Heavy users must not allow these currents to pass into the earth without providing such a path for it as will prevent its seriously interfering with other and milder currents. The Committee evidently do not anticipate that the provision of this path will prevent all disturbance; but having regard to the right for all to use the earth in some form, they cannot call upon large users to do more than employ a metallic return of low resistance, minimise the leakage, and leave small users to protect themselves further if any further protection should be necessary. The provision of the metallic return of low resistance may be a troublesome and expensive matter to large users, but it is reasonable that they should have to furnish it. Further protection may be needed by small users, but it is a refinement which they may be properly called upon to furnish for themselves. This, we think, is a middle course involving the minimum of public inconvenience, and, on the whole, fair to all interests In some such course we anticipated a solution of the problem would be found. The net result of the committee's deliberations is a distinct gain to electric traction in removing from the path the obnoxious conditions of the Plymouth clause, and the Traction Association are to be congratulated on having so fought this case as to have attained this end.

THE ELECTRIC ARC STANDARD OF LIGHT.

ELECTRICIANS will view with satisfaction the activity which is being evidenced in the improvement of photometry. We called attention to the need for it some months ago, and it is gratifying to note that the current scientific serials contain no fewer than three papers by different investigators, each of which is a distinct contribution to our knowledge of this important, yet much neglected subject. Mr. A. P. Trotter describes a new form of photometer; Mr. A. M. Mayer his studies of the phenomena of simultaneous contrast colour, and his new instrument for measuring the intensities of lights of different colours; whilst Dr. S. P. Thompson contributes some valuable notes on the general subject of photometry.

After discussing the use of two overlapping screens as an isophote, and the "periodic principle," in photometry, Dr. Thompson gives prominence to the electric arc standard of light. The experiments made at Chatham by Abney, Cardew, and others upon the electric arc, in 1878, demonstrated the practical invariability of the intrinsic illumination of the crater-surface of the positive carbon of the arc. Abney and Festing, in their researches on the photometry of colour, have since then used as a standard of white light the light of the arc-crater. The invariability of the whiteness, which implies invariability of temperature, is necessarily due to the constancy of the temperature at which the carbon volatilises. Hence the introduction into the substance of the carbons of any material having a lower volatilisation temperature, or of any compound which has a temperature of dissociation lower than that of the volatilisation of carbon, necessarily depreciates the intrinsic brilliancy of the light.

Such considerations naturally lead to the suggestion as a standard of light, the light emitted from a given area of the crater surface of a pure carbon. This suggestion was made by Dr. Thompson on the occasion of the discussion of Mr. Trotter's paper, on "The Light of the Electric Arc," read before the Institution of Electrical Engineers last year. A similar suggestion was independently made by Mr. Swinburne in the same discussion. These suggestions have recently been embodied in an apparatus denominated "arc normale," which has been presented to the Société de Physique, of Paris, by Mons. A. Blondel.

Dr. Thompson, for some time past, has been considering the experimental methods for putting the suggestion in practice. The only way to secure a constant effective area of crater is to produce a much larger crater than is required and cover it by an opaque screen pierced with a suitable aperture of standard dimensions; as this screen must be placed very near the arc, it must be kept cool artificially by circulation of water.

As the intrinsic light of the arc is not far from 70 candles per square mm., a circular aperture 1 mm. in diameter will afford a light of about 55 candles. Hence an aperture smaller than this is preferable in a photometric standard for all ordinary work. For the purpose of a special photometric standard with which to compare other arc lamps, a standard light of 1,000 candles, or some such magnitude, is doubtless advantageous. This would require about 14·3 square mms. of crater surface, or a circular aperture of about 4·25 mm. in diameter.

Dr. Thompson points out that it is easy to ensure the illumination of the apparent aperture by employing a magnet to deflect the arc to the front face of the carbon.

There is an advantage in using, as a standard source of light, one whose light is greater than that of the light under measurement. The light to be measured may obviously be balanced either against a smaller light brought nearer the screen, or against a greater light placed at a greater distance;

but if the greater light at the greater distance be employed, there will, for any given inequality of illumination on the screen, be required a greater actual displacement of the moving part, whether screen or light, in order to arrive at the position of balance. Hence any error in reading the scale will be a lesser fraction of the quantity to be measured.

In his paper, which appears in the July number of the *Philosophical Magazine*, Dr. Thompson adduces arguments in favour of the use of a brighter standard light, and a longer photometric bench than heretofore. Such a standard might well be afforded by an arc crater viewed through a circular aperture, 1 mm. in diameter, giving about 0·7854 sq. mm. of crater-surface, with a light of about 55 candles. Such a pin-hole standard might, with propriety, be treated as a luminous point; whereas no one can maintain that the flame standards habitually used are even approximately points relative to the distance at which they are set from the screen. For them the law of inverse squares cannot possibly be true; though it is never the practice to make any corrections arising from the size of the flame.

More Vibration.

WE showed quite recently that Mr. Justice Cave had a very poor opinion of "expert" evidence, and his remarks when summing up in the case of Dart *v.* Electricity Supply Corporation, must have made the ears of some of the scientific witnesses present tingle uncomfortably. His views upon this subject were probably strengthened by a curious instance of divergence of opinion which came before him in the similar case of Blackie against the same company. Fortunately the point was not a vital one; had it been so the mere opinions of the experts called could not have assisted the jury much. The question was raised as to the nature of the vibration in the plaintiff's house. Prof. Silvanus Thompson, giving evidence on behalf of the plaintiff, said he believed the vibration was chiefly of a lateral character. Dr. Hopkinson, who was on the other side, was convinced that it consisted mainly of a vertical component, and added that such a vertical vibration would be more perceptible at the top of a house than at the bottom. The jury took a short way out of the difficulty by deciding that there was no vibration at all worth making a fuss about.

Economy of Small Stations.

WHILE we in England do not, perhaps, suffer as much as Americans in respect to poor work we are not altogether free from the small station, which, on account of indifferent plant, is unable to pay its way. There is, unfortunately, a tendency wherever a comparatively small station is erected to run it with cheap labour. In the first instance, it may be that the system is absolutely unfitted for the work it has to do, then if there is added to this cheap plant, poor erection and cheap labour, it is not surprising if the station eventually comes to grief. The very nature of things in England is, of course, against this sort of thing, and it is not common. Mr. James B. Cahoon, in the *Electrical World*, has been drawing some realistic pictures of what is done every day in America. Quite large amounts of money have been expended, he says, speaking generally, and all because the plant was founded on a false system of economy. It certainly seems strange to a thinking man of the present day that men who are rated as sound business men in their own profession and business should get together, form a stock company for the purpose of building a plant to light the town, and then fail to consult a competent engineer in regard to the installation of their plant, making of their plans, and supervising the work in general. This is the first false move, and the second is quite as bad, which is the employment of some young man who has a slight knowledge of electricity in general, knows something of engines, and has seen a boiler fired, to take the position of superintendent and electrician because his services can be obtained for about $60 a month. Following out this system in the employment of the men under him, the selection is made usually on the score of economy—that they must get as cheap a man as possible—and accordingly they get some man for a fireman, and pay him $1.50 a day, a lamp trimmer for the same price, and so on; the result being the failure of the station, and its purchase by a syndicate who understand the business, have the advice of a competent engineer, select first-class workmen for their station, pay them good wages, purchase new apparatus of the best make, reconstruct their lines and overhaul the plant in general, putting it in first-class condition, and in the course of a year or two we find them paying a very handsome dividend on the amount expended, and quite sufficient to pay a 6 to 8 per cent. dividend on the total amount that has been expended on the plant.

How the Station was Run.

IN one small station that came before Mr. Cahoon, during the first year quite extensive repairs had to be made on one of the boilers, owing to the crown sheet having burned through, due to the carelessness of one of the firemen in letting the water get too low; and the armature of an arc machine, which was designed for 50 lights, had to be twice replaced on account of overload, the superintendent boasting he could get 80 lights out of it, and usually did so, having at one time, he said, run as high as 85 lights. At the end of the first year the installation showed an apparent dividend of a little over 5 per cent. on the investment, the next half year showed an increase in expenditure, as repairs had to be done to the engine, the line kept giving trouble from frequent grounds, the insulation dropped off the wire, and so on. From that time forward the plant has never shown a dividend of over 2¾ per cent. It is a distinct advantage to publish such statements as these, for it must set proprietors of stations thinking.

The Moral.

THE moral of all this is that you cannot expect to work on economical lines if things are not done well from the outset. It is a well recognised truism in other businesses that you cannot get good work without paying a good price. The difference between the initial cost of cheap and good work may be great, but eventually, if the cheaper be adopted, the balance will be the wrong way. We would urge this upon those who are too prone at the present moment to accept the lowest tender for electrical work. We have frequently pointed out that tenders have been often accepted at a price which must absolutely debar sound work. Such work cannot stand the test of time, and those who endeavour to secure a temporary advantage will obtain a permanent disadvantage.

On the Transparence of Ebonite.

SIGNOR RICCARDO ARNÒ has been further carrying out the lines of research undertaken by Profs. Ayrton and Perry, by Abney, Festing, Preece, and J. J. Thomson, and has arrived at certain very interesting results. He concludes from his experiments that ebonite in thin leaves is not transparent in the same degree for all the radiations of obscure heat. It is so much more transparent for such radiations the more they are refrangible, and, in the highest degree, for those of the shortest wave length. Its diathermanic power is greatest when the source of heat is one from which there emanate thermic radiations of small wave length. It is known that if the leaves of ebonite are thin enough it is transparent, also for the visible radiations which are less refrangible. Ebonite in thin leaves arrests the radiations of obscure heat so much the more easily the less they are refrangible. As with the other substances, the diathermanous power of a leaf of ebonite increases with the degree of brightness of its surface and diminishes with its thickness.

ARC LIGHTING.

BY E. TREMLETT CARTER.

(*Continued from page* 6).

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VII.

ANOTHER form of lightning guard is used by the Westinghouse Company on arc light circuits, and possesses some points of sufficient interest to make it worth our consideration here. The apparatus, which serves for both terminals of the dynamo, is arranged as shown in fig. 18. The main

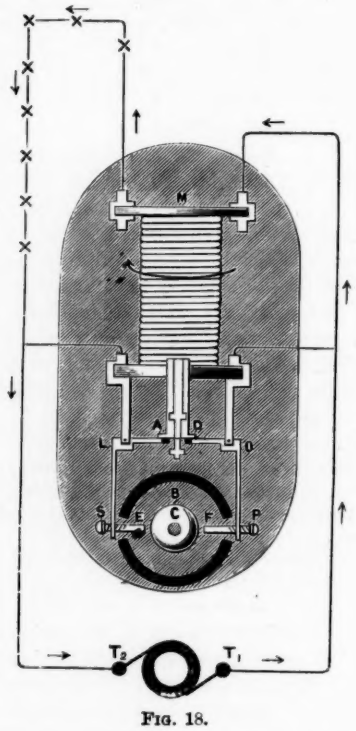


FIG. 18.

current passes from the terminal, T_1, to line through the electro-magnet, M; thence to the lamps, in series, and back to the terminal, T_2. The magnet is adjusted vertically on a base board, and immediately beneath it and fixed upon the same board, is the earthing device. This consists of a carbon button, C, supported inside a protecting box, B, and well earthed. On either side of the carbon button there is a spark-gap electrode, which may be adjusted by the screw, S or P, and which is fixed on one or the other of the two bell-crank levers, L and O. The soft iron core of the electro-magnet is usually sucked into the inside of the solenoid when the current is passing; but, if the line is struck by lightning, the flash passes from line to earth through the two spark-gaps on either side of the carbon button, and the arc thus formed may divert the dynamo current to earth. Should this happen, the solenoid will be short-circuited, and will immediately release its iron core. The core will fall heavily upon the tops of the two levers at A and D, and, pressing upon them, will cause the spark-gaps to become suddenly elongated. The result will be that a brilliant arc will flare up at each of the spark-gaps, generating so much heat that the air enclosed in the box, B, will suddenly expand and rush from the box through the two apertures, E and F. This rush of air blows out the arc, and thereby disconnects the line from earth, with the result that the current once more passes through the solenoid, and the apparatus is ready for the next flash.

9. *Calculations about the Line.*—In order to be able to design the generator, as well as for minor reasons, it will next be necessary to make some calculations about the working conditions of the line which we may have designed. The two most important of these calculations are the fall of volts or drop in the line when working, and the loss of power under the same condition. The amount of leakage of current is also important, though not so necessary to know beforehand if good insulation has been provided; and this factor is difficult, sometimes impossible, to pre-determine to any useful degree of accuracy. We shall deal with these three points in order.

The drop in voltage, due to the resistance of the line, is equal to the product of the working resistance of the line in ohms into the current in ampères. The latter factor is determined by the requirements of the lamps; the former, by the dimensions, quality and working temperature of the line. If R is the resistance of the line at any temperature, and R_1 its resistance at the temperature $t°$ F. higher, then

$$\log. R_1 = \log. R + t \,.\, \log. (1 + a)$$

where a is a constant depending upon the material, known as the temperature coefficient. The value of this constant for most pure metals is approximately 0·0021; from which it follows that such metals increase in resistance about 0·21 per cent. for 1° F. rise in temperature. Iron forms a notable exception, the increase being about 0·26 per cent. per degree Fah. Impurities slightly increase the temperature coefficient. If, then, the resistance of the line at some standard temperature is known, and if the amount of rise above this temperature during working is also known, we may determine the working resistance by the above formula. The standard resistance of the line may be obtained from the tabular resistance of any unit of length, since if the joints are properly made they will not affect the resistance. The tabular resistance must be multiplied by the number of units of length in the entire circuit. The value of t, which must be taken, will be the highest probable value above the standard temperature, since it is required to ascertain the greatest drop which will occur. This is not so easy to calculate exactly, and the best method to adopt is the following: If the conductor is a bare overhead wire, the highest rise of temperature above surrounding objects may first be roughly judged, and this added to the highest summer temperature will give the approximate maximum value of t; with this rough figure the approximate resistance of the line may be determined, after which a closer approximation may be obtained from the following modification of Prof. Forbes's formula,

$$\theta = 3{,}333 \frac{C^2 \,.\, s}{\delta^3}$$

where θ is the rise in temperature in degrees Centigrade above the surrounding temperature, C is the current in ampères, s is the specific resistance of the material at the approximate highest working temperature, in ohms per centimetre cube, and δ is the diameter of the wire in centimetres. From this new value of θ we may get a closer value for t, and thereby a closer value for the highest working resistance.

If the conductor is a covered overhead wire insulated with India-rubber, the formula for θ becomes

$$\theta = 117 \,.\, s \left(\frac{C}{\delta}\right)^2 \left(\frac{10 + 3\,D \log_\epsilon \frac{D}{\delta}}{3\,D}\right)$$

where D is the diameter in centimetres of the covered cable, and the other symbols have their former meanings. Where the line is placed underground the conditions are such that it is practically impossible to give a general equation for the rise in temperature. In such cases the working resistance may be calculated for the highest temperature permitted by the Board of Trade, viz., 30° Fah. above the highest surrounding temperature. The drop determined from such a calculation will not be seriously different from that which actually will take place.

The power, in watts, wasted in the line may be found by multiplying the current in ampères into the drop in volts, or by multiplying the working resistance in ohms into the square of the current. Dividing this by 746, we get the electrical horse-power expended against the line resistance. More power will be wasted in this way when the line is hot than when it is cool, in summer than in winter; but it will be most important to know the value of the maximum which will be wasted, in order to ensure the provision of sufficient power at the generators. If there is much leakage taking

place, the power wasted in the line, from all causes, may be found by subtracting the watts delivered from the watts supplied; that is, by subtracting the product of the volts and amperes at the working end of the line from the product of the volts and amperes at the generator end of the line. Except where the line has considerable electrostatic capacity and is worked with alternating currents,* the product of the volts into the amperes will give the watts at either end of the line. In the event of an alternating current being used where the line has some capacity, there will be an alternate charging and reversal of charging in the line, whether there is any current passing out to the lamps or no. The effect of this is to increase the apparent watts sent into the line, the extra watts being determined by the equation—

$$w = \frac{2\,n\,\text{K}\,\text{V}\left(\text{V} - \frac{v}{2}\right)}{10^6}$$

where n is the frequency of alternation, K is the capacity in microfarads, V is the voltage of supply, v is the drop over the entire line, and w is the number of watts which are apparently, but not really, supplied to the line. If we deduct these apparent watts from the product of the volts into the amperes supplied to the line, we shall obtain the true watts supplied.

The amount of leakage of current from the line depends upon three factors: the standard insulation resistance of the line, the working temperature, and the average voltage along the line. The standard insulation resistance, as per specification, will be higher than the standard insulation resistance when erected, in proportion as the line is roughly handled and badly jointed. Age will cause a further degeneration from the initial standard value. The effect of a rise in temperature above the standard is more marked than, and is in the opposite direction to, the effect upon the conductor. All known insulators diminish in resistance with a rise of temperature, and those which are commonly used for covered cables or for high tension bare wires suffer diminution at a very rapid rate. Thus, some qualities of gutta-percha diminish at five times the rate that copper increases for the same *small* change of temperature, while considerably larger changes of temperature reduce the insulating power to a very small fraction of its initial figure. It is to be regretted that so marked a change in the quality of the insulation cannot in general be accurately pre-determined. The temperature coefficients of this class of substances are functions of the treatment, age and quality of the materials to such an extent that it is impossible to predict the effect of any given rise of temperature on a cable unless the entire process of manufacture is taken into account. The best course open to the engineer, then, is to specify a cable which shall stand a certain rise of temperature without more than a certain fall of insulating power; and to verify this provision by actual tests made upon a sample of the cable, or on the cable itself. This being done, and a proper margin having been introduced for reduction of insulation on account of the joints, the working insulation resistance may be fairly well determined. Even this, however, does not allow for the deterioration due to ageing of the insulation.

The Board of Trade requires that the cables shall be tested for insulation resistance after they have been completely laid in the conduits or placed on the poles, and before any lamp or private house connections are made. Under these conditions it is impossible to test the cables "hot" with full current on, so that the insulation resistance which the test will determine will not be so low as the working resistance. The Board requires that this test shall be carried out under a pressure of not less than 100 volts, and that the insulation resistance shall be not less than 100,000 ohms per mile per volt of pressure of the supply.

10. *Lamp Transformers.*—Before concluding this chapter upon the design of the circuit details it will be necessary to say something about the design of small alternate current transformers for arc lamps, which form a necessary part of the circuit in alternate current high tension supply. We have already remarked that the most economical method of supplying arc lamps over an extended area is the method adopted largely in America, namely, that of putting each lamp on a transformer on a high tension system of mains. The advantage lies in the economy of copper and of power. Contrasted with the low tension parallel system, this one affords an immense saving in copper. Contrasted with the ordinary series system, it affords on all circuits where the lamps must be far from the centre of supply, an immense saving in power which would be wasted in the mains. In the parallel system the section of copper that would be required to carry a given amount of power a given distance with a given loss, will vary inversely as the square of the voltage of supply; so that the copper economy at 2,000 volts compared with 50 or 100 volts would be such that only $\frac{1}{1600}$th or $\frac{1}{400}$th of the copper would be required. On long mains, or where there is a large current per lamp, the cost of a transformer to each lamp is not so great as the saving in the cost of copper, so that there is a net gain in adopting the transformer system over extensive areas of supply. In the ordinary series system, the number of lamps which can be worked on any one circuit will depend on the maximum voltage which is to be adopted. Putting this at, say, 2,600 volts, we may have about 50 lamps on each series. If more than this number of lamps is required, there will be more than one series, and all the series will be worked in parallel from one or two large machines, or each series will be worked separately. In either case, remote lamps will require very long mains to reach them; mains which will not have many, perhaps not any, intermediate lamps. These long mains will waste as much power as if they were filled up with lamps, so that on an extended system the cost of waste power per lamp becomes very large. With alternate current transformers, placed either in series or in parallel, there may be more lamps used with any given primary voltage; there is perfect safety in the handling of the lamps, and there is a very high prime cost economy.

In the design of transformers it is commonly the practice to use C.G.S. measurements, and these will be principally employed in the following calculations. The merits of this system are discounted by the inconvenience of adapting and welding it to long-established workshop methods, so that the author has added some formulæ for the design of a transformer in which the measurements are reduced to the English scale. To commence with, we must decide upon the primary and secondary voltages, the power which the transformer is to supply to the lamp, and the loss of power which is to take place in the transformer. A fourth consideration—the cost of making the transformer—will be necessary; but experience shows that this is involved in the losses which we allow to take place in the coils and the iron core. If we allow a reasonable amount of loss of power, such as is determined by experience, we shall obtain a proportion of detail which will not be unreasonably expensive. On the other hand, if we try to keep the losses down, we may find that the machine will be altogether too expensive to make.

In parallel work the primary voltage at the transformer will be the voltage of the mains, and will be determined by the extent of the area of supply. The secondary voltage will be determined by the working voltage of the arc lamp, and, since there will be no drop from the transformer to the lamp, will be equal to about 50 volts. The power which the machine must supply will be equal to that required by the lamp; while the power which it will take from the primary mains will be equal to this *plus* the transformer losses.

We next design the primary coil, arranging to have a definite waste of power and a definite current density. The current which this coil will have to carry may be obtained by dividing the full load watts at the primary terminals by the primary voltage.* If we allow a density Δ amperes per square centimetre we must have a section of copper equal to—

$$s_1 = \frac{c_1}{\Delta}$$

where c_1 is the primary current. Δ is usually about 240. From this section we may ascertain the proper gauge of wire. To find the necessary length we assume that there will be W watts wasted in both the primary and secondary coils, and that there will be half this quantity in each coil. The length of the primary wire, in centimetres, will then be—

$$l_1 = \frac{10^6 \cdot \text{W}}{861\,c_1},$$

* Self-induction is negligible.

* The power factor at full load is here taken as unity. In any type of transformer in which it is less than unity at full load, the result must be multiplied by the reciprocal of this factor.

and its resistance,

$$r_1 = \frac{16\ l_1}{10^7\ s_1},$$

assuming that the copper has about 100 per cent. conductivity. The copper losses in a small transformer, W, may be taken as about 1·75 to 2·0 per cent. of the power which it will supply to the lamp. For larger transformers it may be as low as 1·25 per cent.

The secondary coil may be designed from the primary by means of the coefficient of transformation, *i.e.*, the ratio of the primary to the secondary volts. If the length of the primary coil is divided by this ratio, and the section of copper of the primary is multiplied by it, the length and section of the secondary coil will be respectively obtained, To find the right proportions for the magnetic circuit, let B be the maximum magnetic induction per square centimetre section of iron, let A be the section of iron in the core, n the frequency of the alternating current in complete alternations per second, and T_1 the number of primary turns of wire. Then, the maximum E.M.F. induced in the coil will be—

$$E_1\sqrt{2} = \frac{2\pi n\,B\,.\,A\,T_1}{10^8},$$

from which, by transposition, we get—

$$A\,T_1 = \frac{E_1\sqrt{2}}{2\pi n\,B} \times 10^8.$$

In order to determine the relation between A and T_1, which will solve this equation for either, we must now decide on the shape of the section of the core and on the amount of insulation around it and between the laminæ. In fig. 19, let the

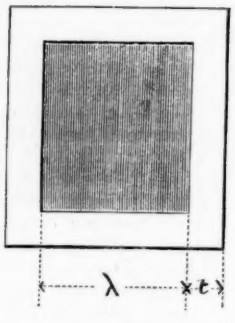


FIG. 19.

inner square represent the core, and the space between the two squares the insulation, the latter having a thickness, t. Let p per cent. of the inner square be iron, the rest being made up of insulation between the laminæ, and let λ be the side of the inner square. Then

$$A = \lambda^2\left(1 - \frac{P}{100}\right).$$

Therefore

$$\lambda = \sqrt{\frac{A}{1 - \frac{p}{100}}}$$

Let λ_1 be the length of one primary turn, then

$$\lambda_1 = 4\,(\lambda + 2\,t)$$

$$\therefore\ \lambda_1 = 2\,t + 4\sqrt{\frac{A}{1 - \frac{p}{100}}}$$

But

$$T_1 = \frac{l_1}{\lambda_1}$$

Therefore,

$$T_1 = \frac{l_1}{2\,t + 4\sqrt{\frac{A}{1 - \frac{p}{100}}}}$$

Substituting this value, we get

$$A\,T_1 = \frac{A\,l_1}{2\,t + 4\sqrt{\frac{A}{1 - \frac{p}{100}}}} = \frac{E_1\sqrt{2}}{2\pi n\,B} \times 10^8$$

From which the value of A may be obtained, and the proportions of the core section may be arranged. The quantity, p, varies in different types of transformers from 45 to 95 per cent. The induction, B, must not be too high, otherwise the iron is overheated and rapid reversals of the magnetisation will cause a humming noise. It is usually about 10,000 C.G.S. lines per sq. cm. of the iron.

Having now determined the section of the iron and the amounts of copper in the two coils, it will be necessary to design the length of the magnetic circuit which will suit these conditions. This we may do in one of several ways: we may adopt a certain proportion between the weights of iron and of copper, and is done by some makers when a definite type of transformer has been established, or we may design the iron so as to get a definite number of layers of coil windings over the iron, making the iron path so long that this number of layers and no more will be necessary; or, finally, we may calculate what amount of iron will keep the loss of power in the iron down to a certain pre-arranged value, and wind the coils to suit this amount of iron. For simplicity's sake, we shall here consider only the last of these three methods, because it lends itself best to exact calculation; but it must be remembered that the first method is the one most commonly adopted in those instances where practice is established. Suppose L to be the length of the mean path of the magnetic induction, and that there is an uniform section of field throughout, then A L will approximately represent the volume of the iron. Next, suppose that the quality of the iron and the degree of lamination are such that we may depend upon having only e watts wasted in each cubic centimetre of the iron on account of hysteresis and Foucault currents. Then, the losses in the iron will be:

$$\text{watts wasted} = e\,.\,A\,.\,L.$$

But, if we decide to make these losses only a given per cent. of the total output of the transformer, say H watts altogether, we have

$$H = e\,.\,A\,.\,L.$$

From this equation we may obtain the length of the mean path of the induction in the iron. The quantity, e, will generally vary between $\frac{1}{50}$th and $\frac{1}{20}$th of a watt per c.cm. of iron; and the total iron losses will vary from about 20 watts in a small transformer giving 250 watts output, to 45 watts in a transformer giving 2,000 watts output.

(To be continued.)

THE TREATMENT OF RODENT CANCER BY ELECTROLYSIS.*

BY J. INGLIS PARSONS, M.D., M.R.C.P., M.R.C.S., LONDON.

THIS disease, better known in England as rodent ulcer, was first called rodent cancer by the late Mr. Moore in his work on the subject. Half a century ago it was confounded with lupus, syphilis and infective epithelioma, but it is now known to be a local form of malignant disease closely resembling true epithelioma. Lebert and Hiersch included it among the epitheliomas. Billroth considers it to be a mild form of cancer of the skin. Sections taken from a small piece of growth removed from one of my cases showed the following structures: Pervading all parts of the diseased tissues were large numbers of new cells. The majority have the appearance of small epithelial cells. In the older portions of the growth they exhibit the irregular and larger shape characteristic of the squamous-cell epithelioma. Here they are more crowded together, and in a few places form the concentric arrangement called epithelial nests. The arrangement of the small epithelial cells varies in different parts. In one place aggregated together into columns as if pushing their way into the healthy tissue; in another part filling a distinct alveolus formed by delicate connective tissue. A great portion of the stroma appears to be a structureless matrix, with the new cells imbedded in it, and has very much the appearance of a round-cell sarcoma.

The disease nearly always commences as a small pimple on the side of the nose, or between the eye and the nose. It is not painful or tender like the inflammatory papules which are common on the nose of persons of gouty habit. Instead

* The *Medical Week*.

of forming a posture or disappearing by absorption, the pimple begins to ulcerate. It slowly continues to increase, gradually extending in every direction into the healthy tissues. Meanwhile the ulceration proceeds in the older portions of the growth. In advanced cases that have not been checked by treatment, the whole of the face may be destroyed. Bone, cartilage, muscles, connective tissues, all disappear before the invader.

The clinical appearance varies according to the duration of the disease; an early case presents a small ulcer with a sinuous slightly elevated border. The base is smooth and and glazed, of a dull red colour and devoid of granulations. There are no tubercles in the surrounding area and very little induration.

At a later stage when the growth is more rapid, the appearance is different. In some parts the edge of the ulcer is still but slightly raised, but in other parts it is greatly thickened and presents a rounded, semi-elastic, somewhat translucent appearance. The lymphatic glands are not enlarged even in advanced cases unless there has been some inflammatory action in connection with the ulcer. Nor is there much infiltration of the healthy tissues. The extent to which this takes place varies according to the duration of the disease. In the older portion it is greater than in the more recent growth.

The age of the patient is nearly always over 50. One sex is as much liable to be affected as the other.

The diagnosis presents no difficulty to an experienced surgeon. The long duration of the disease, the absence of enlargement of the lymphatic glands and the appearance of the ulcer, distinguish it from true epithelioma.

Syphilitic ulcers are usually circular or oval, and often multiple. The edges are sharply cut and abrupt, and surrounded by an area of dusky red or even livid skin, which is very characteristic.

With syphilis there are always other symptoms and marks of the disease to be found associated with ulceration in the tertiary stage.

Lupus is found in young subjects. If still existing in patients over 50 numerous scars will be found as the result of former attacks, as well as other evidence of strumous disease, soft tubercles being usually found in the skin outside the area of ulceration. A tendency to exuberant granulations is characteristic of the ulcer.

Treatment.—Whatever method of treatment be adopted the object aimed at is the complete destruction of the disease with as little as possible of the healthy tissues, so as to avoid disfigurement. Three methods can be adopted, viz., electricity, caustics, or the knife.

Advantage of Electricity.—Applied by the method about to be described, it has the following advantages:—

(1.) It causes no pain. For several days after the application sensibility is abolished in the ulcers.

(2.) There is no loss of blood and no shock. It is well-known that operations with the knife cause profuse hæmorrhage in these cases, on account of the great vascularity of the face.

(3.) The absence of hæmorrhage enables the operator to see exactly what he is about. No more tissue is destroyed than is absolutely necessary.

(4.) Electrolysis has this advantage over the galvano-cautery and other caustics. It can be regulated with the greatest nicety and within the widest limits, by increasing or decreasing the strength of the current.

No doubt complete healing can be obtained with excision by means of the knife. But however brilliant the operator may be the profuse hæmorrhage which occurs renders the task very difficult.

The application of strong caustics such as chloride of zinc or nitric acid causes great pain. It is also very difficult to regulate with any precision the amount of tissue that will be destroyed when liquid caustics are applied.

Operation.—The anæsthetic most useful is chloroform, unless the patient is very old, when I prefer the A C E mixture. The battery consists of two Stohrer Hospital batteries joined together to increase the strength of the current.

They must be freshly charged and tested before the anæsthetic is given. Any strength from two cells to eighty can be used as required. The galvanometer—Edelmann's—is placed on a pedestal table so that the operator can see the strength of the current employed. Two assistants are required, one to work the batteries and the other to help the operator.

The needles used are from 2 to 4 inches long composed of steel with platinum ends. The steel portion is insulated and attached to some 18 inches of covered wire. When the patient is fully under the assistant at the battery brings into circuit 20 cells and then turns the current on for one or more seconds as required. Meanwhile the other assistant holds the needles in position, while the operator feels the pulse, observes the strength of the current shown by the galvanometer and the effect produced on the growth.

After one or more seconds the current is turned off. If the breathing and pulse are unaffected the circuit is closed again, but in the alternate direction by means of the commutator on the battery. The number of cells is now increased, until the strength of the current reaches from 300 to 400 milliampères, provided the pulse and respiration are maintained. The assistant continues to alternate the current and diminish or increase its strength according to the directions of the operator. The position of the needles must be changed when sufficient destruction has taken place. A fresh portion is then treated until the whole of the growth is destroyed. Full advantage is taken of the caustic action at the poles and only two needles are used at a time. Between the needles there is also some destruction of tissue lying in the direct path of the current between the poles. This is not so apparent at the time of the operation as the polar action.

Although most of the current passes by the shortest route from one needle to the other some of it is diffused and goes through the healthy tissues lying outside the growth. In this region it is much weaker and appears to have a stimulating effect on the healthy tissues.

Duration of the Operation.—This will depend on the size of the growth and the dexterity of the operator. With a small ulcer a quarter to half an hour is sufficient. When the disease is extensive, two, or even three, applications may be necessary.

Risk of the Operation.—I have not as yet lost any case of rodent carcinoma, and I consider that the risk is very small indeed in the hands of a careful operator. I have applied electrolysis on eight occasions for this disease, in one case to an old man of 80, two years ago, and he is still alive and well. Up to the present I have not noticed any alteration of the pulse when operating on the face.

After-results and Treatment.—The patient is usually able to get up the next day. For some cases an evaporating lotion is useful for the first 48 hours. The wound must then be syringed two or three times a day with an antiseptic lotion, and covered with an ordinary dressing. At the end of a week healthy granulations begin to appear and healing soon takes place. If the ulcer is extensive, it is best to expedite matters by grafting some pieces of skin. There is no depression and no pain after the operation.

Prognosis.—Every case that I have treated has healed completely in the course of a few weeks. In some at the end of a year or eighteen months, the disease has reappeared but it has always been easily stopped by a short application of the current. In fact the disease can always be kept under control except in extreme cases. A year's immunity can always be promised if the operation is carried out thoroughly. Practically complete immunity is obtained if on the first sign of recurrence a short application is made to the diseased part.

Electro-motors for Domestic Use.—Messrs. Bauer and Betz, of Berlin, are making a speciality of small electro-motors for domestic use and for small industries, and which are sparkless, and have a high efficiency. The firm has undertaken tests to ascertain whether the employment of gas engines, oil engines or electro-motors was the most desirable for such purposes, and the conclusion arrived at was pre-eminently in favour of the last, not only as regards simplicity, cleanliness and convenience, but also as regards cost. Central stations are anxious to get consumers of current for power purposes, the Berlin Electricity Works, for instance, only charging 2 pfennig, or, say, 0·25 of a penny for 100 watt-hours for the supply of energy from their street mains. At this price the electro-motor can very readily compete against gas and oil engines.

C

MOVABLE BORING MACHINE WITH ELECTRIC PROPULSION.

[FROM OUR OWN CORRESPONDENT.]

THE accompanying illustrations represent two views of a boring machine constructed by the firm Ganz & Co., of Budapest, and now actually at work. It is propelled by electricity and includes:

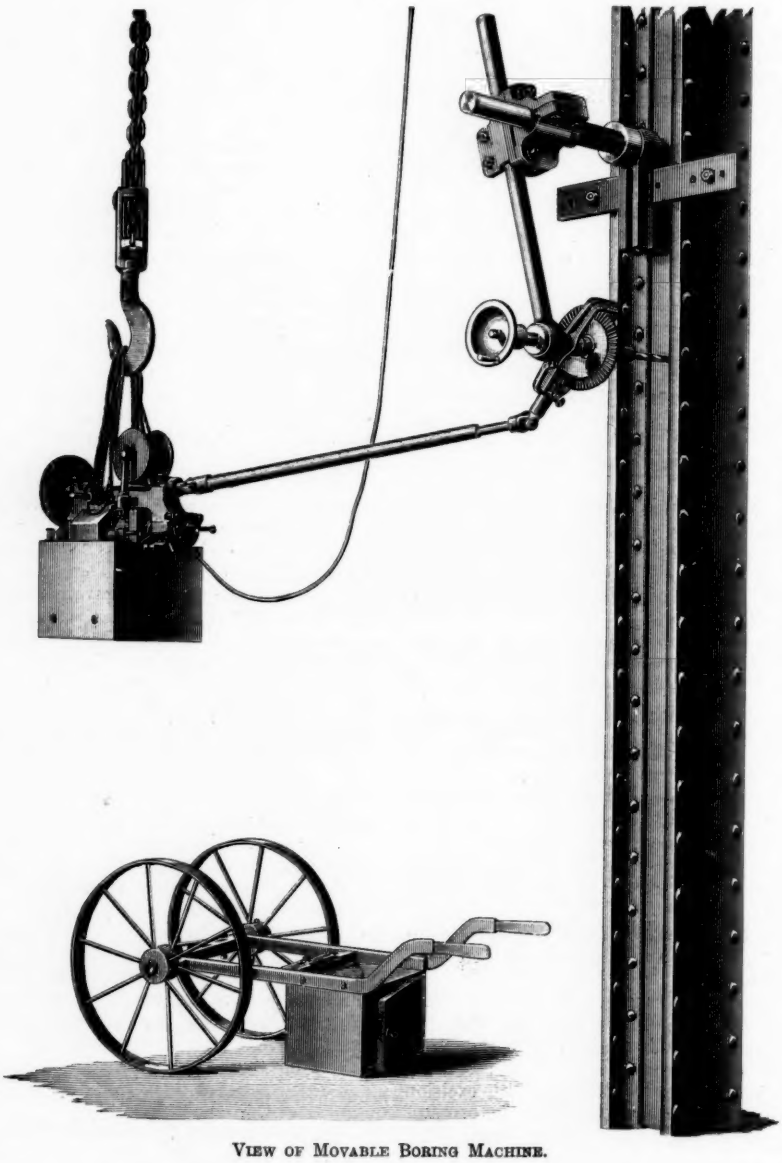
1. The travelling electromotor with the transfer fittings, supply of current, and tool chest. 2. The boring apparatus.

The travelling motor consists of a light frame with two wheels carrying the electromotor itself and the accessory starting rheostat, the arrangement for transfer and a cylinder to receive the conductive cable. From the shaft of the motor a second shaft, fixed above the motor, is driven by means of a pair of wheels capable of being exchanged, from which the motion is transferred to the boring apparatus. All the parts are combined in a simple manner to form a whole, which is secured to the frame-work of the wheels by means of four screws.

In order that the boring machine may be applicable even in cases where the size of the article to be acted upon does not permit of the motor being driven sufficiently near, it is arranged so that the entire apparatus, after the four screws have been slightly eased (not taken out) may be lifted from its support and suspended in any desired position.

The arrangement for transfer is formed by a tubular shaft capable of being drawn out to the length of 2 metres, which, on the one hand receives the motion of the driving shaft by means of Hooke keys applied at its ends, and on the other hand transfers it to the boring apparatus.

The supply of current is effected by a flexible cable, well insulated, coiled up on a drum placed above the motor. The convenient supply of the necessary motive power, together with its universal applicability and ready portability constitute a chief advantage of this boring machine. The working current is simply taken from a light installation which is, in general, already at hand. For this purpose the supply cable is provided with terminals by means of which a connection with the lead can be at once effected anywhere.



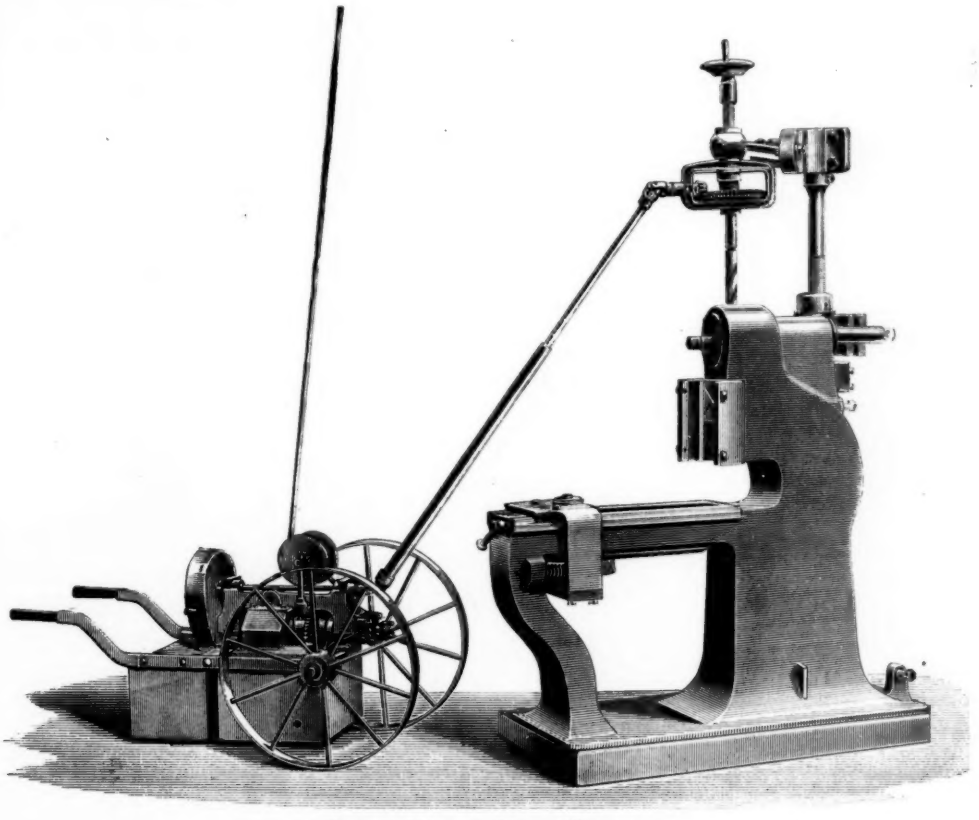
VIEW OF MOVABLE BORING MACHINE.

The boring apparatus consists of a strongly constructed arrangement for connection, a universal joint and a boring apparatus in the stricter sense of the word. It can be easily and safely fixed anywhere, and the boring spindle can receive any desired direction independent of the position of the motor.

The rapidity of the boring spindle can be adapted to any purpose. To this end the toothed wheels on the motor and the intermediate shaft are made interchangeable. As a rule two different pairs of wheels are supplied along with every boring machine.

The normal type of the travelling motors is built for a working tension of about 100 volts. The motor shaft makes

about 1,000 revolutions per minute corresponding to 67 or 145 revolutions per minute, according as the toothed wheels for slow or quick movement have been fixed to the motor. The maximum power required is rather less than 1 H.P., and it is sufficient to bore with ease holes of 35 millimetres in diameter.



VIEW OF MOVABLE BORING MACHINE.

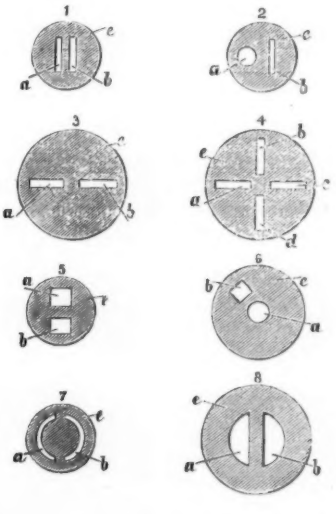
It may be added that in the wheel work bronze runs upon cast-iron, and that the principal journals are fitted with a long-tried annular lubrication in which a single supply lasts for several weeks' permanent work. The weight of the complete apparatus is 245 kilos., that of the boring apparatus 110 kilos.

PREECE'S IMPROVEMENTS IN SUBMARINE TELEGRAPH CABLES.

MR. W. H. PREECE in his recent inaugural address before the Institution of Electrical Engineers, stated that he had devised a form of submarine cable which would enable the speed of working across the Atlantic to be quadrupled ; the arrangement of this cable, according to the words of the patent specification just published, is as follows :—"In long submarine cables as at present constructed, the speed of working and therefore the rate of flow of successive currents of electricity, whether intermittent or alternate, is regulated by the electrostatic capacity and the resistance of the core. It follows a distinct and definite law which is expressed by the formula, speed of waves $= \alpha K R$, K being the total inductive capacity, and R the total electric resistance of the core.

"I have found by experiment that the value of K can be very materially modified by the influence of mutual induction between two parts of the circuit when the circuit is metallic and the core compound ; in fact, the geometrical relations between the insulator and conductors can be so modified that K may be practically eliminated.

"In submarine cables I propose, therefore, according to my present invention to avoid the use of the earth as a part of the circuit, and to make the circuit entirely metallic ; I propose to construct the core of two conductors either cylindrical and parallel, or cylindrical and concentric, or rectangular and parallel, separated from each other and from the water by insulating media, and so arranged as regards geometrical form, that the effect of the mutual induction of the two conductors shall oppose and neutralise the effect of their inductive capacity. In this way I propose to materially expedite



the rate of working by telegraph, to extend the distance to which speech by telephone through submarine cables is possible, and to eliminate from cable working many existing sources of trouble and difficulty owing to the use of earth.

"The drawings show by way of example sections of various forms and arrangements of submarine cable cores having two

conductors forming a complete metallic circuit according to the invention.

"In fig. 1, the two flat rectangular conductors, *a* and *b*, forming the metallic circuit are imbedded in one and the same insulating sheath, *e*, side by side and parallel to each other, at a suitable distance apart for insuring perfect insulation from each other; in fig. 2, the one conductor, *a*, is cylindrical and the other, *b*, flat; in fig. 3, two flat conductors, *a*, *b*, are placed edge to edge; in fig. 4, there are two metallic circuits formed by four flat rectangular conductors, *a*, *b*, *c*, *d*, any two of which may together form a circuit.

"Fig. 5 shows two conductors, *a* and *b*, of a square section.

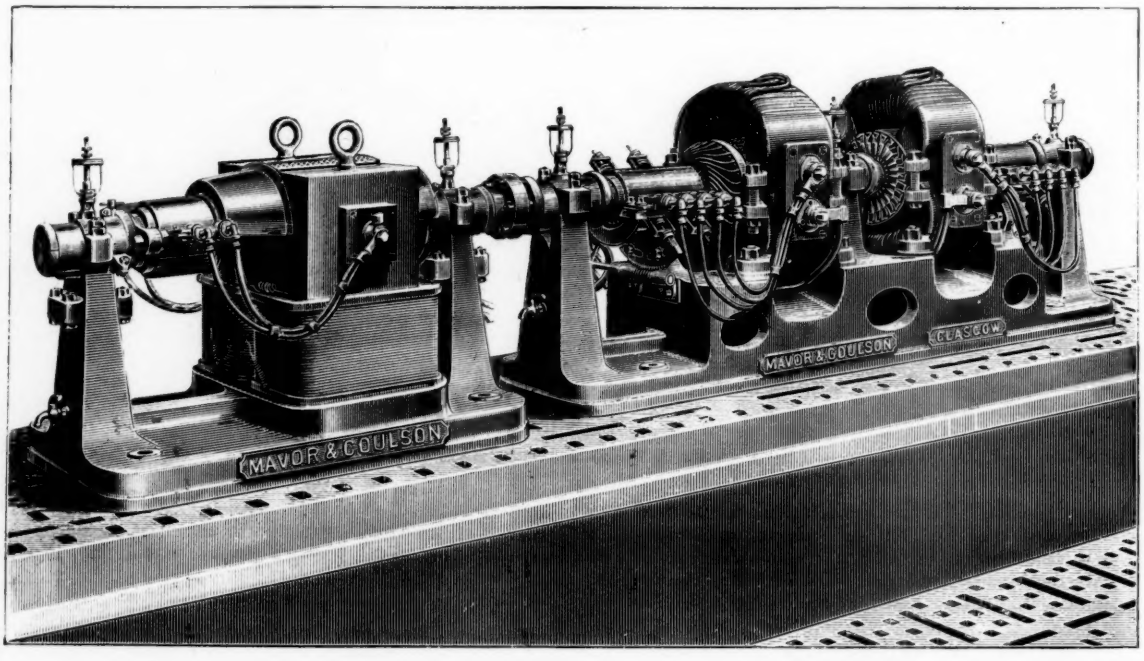
"Fig. 6 shows a conductor, *a*, of circular section and one, *b*, of a square section.

"Fig. 7 shows two conductors, *a*, *b*, of a semicircular or arc shaped section, placed opposite each other so as to form a circle, with part of the insulating core intervening between the meeting edges.

"Fig. 8 shows two conductors of segment shaped section.

"The current would be worked by any suitable known method in cables of the above described construction.

"The weight of the conductors would vary with the length of the cable. The serving of the cable and its armouring would be the same as for ordinary cables."



COMPENSATORS FOR FALL OF PRESSURE IN FEEDERS.

THE above illustration is taken from a photo of a new compensator for fall of pressure in feeders, constructed on Sayers's new principle by Messrs. Mavor & Coulson, of Glasgow, for the Derby electric lighting station of the Midland Railway. The compensators have been designed by Mr. W. B. Sayers and his brother, Mr. J. Sayers, of Derby, to keep the pressure constant at the distant ends of the feeders in a low pressure three-wire system. They will be placed in the engine room, the current to the feeders which they control passing through them, by which means the pressure is automatically raised by an amount just sufficient to compensate for the drop in the feeders with whatever current may be flowing, thus dispensing with hand regulators and also the necessity for pilot wires.

The compensators proper consist of a pair of low tension series characteristic dynamos, mounted on the same shaft, and driven direct by a motor at a constant speed. The current to the extreme positive feeder traverses one of the armatures of the compensators, and that to the extreme negative feeder traverses the other armature, and the current to each feeder in so doing produces a magnetic flux proportional to itself through the armature and keepers which form magnetic circuits.

The magnetic flux reacts on the winding of the armature, causing an addition of pressure also proportional to the current passing. Adjustments are made so that the amount of the added pressure exactly compensates for the drop in the feeders. The manner in which this result is obtained is described in detail in Mr. Sayers's paper recently read before the Institution of Electrical Engineers, on "The Prevention of Sparking," &c. In order to compensate for the drop of pressure in the third or centre wire when a current is flowing in it, this current is led around the respective keepers in such a manner as to compensate exactly for the disturbance which is caused by the drop when a balancing current flows owing to the two sides being unequally loaded. This is a most important feature, as all engineers who have experience with the problem of keeping pressure constant in a three-wire system will agree. We are unable to describe in detail the way in which this result is obtained, as the protecting process is not yet complete. Two sets of compensators have been constructed for the Derby Station, one to carry a maximum current of 500 ampères, and to raise the pressure in the proportion of 1 volt for every 95 ampères of current flowing; and one to carry a current of 400 ampères to raise the pressure in the proportion of 1 volt for every 55 ampères. In each case the third-wire arrangement is adapted for a three-wire system, in which the centre conductor has a sectional area equal to one-half the area of the two outer ones.

THE ELECTRIC WORKS AT FURSTENFELD-BRUCK.*

THE electrical works at Fürstenfeld-Bruck have hitherto been only briefly mentioned in the *Elektrotechnische Zeitschrift*. At present, by means of documents kindly placed at our disposal by Oscar von Miller, the constructor of the works, we are able to give a full account of the installation.

The Fürstenfeld works are especially interesting as affording proof that electric light stations may be of advantage not alone in great cities, but in relatively small places, as they not merely effect a light which under certain circumstances is very cheap, but give a new impulse to industry by furnishing a cheap motive power. The parish, Fürstenfeld-Bruck, had

* From the *Elektrotechnische Zeitung*.

acquired a mill site, Schöngeising, for the waterworks and for an electric light station.

For generating and distributing the electric energy the alternating current system was selected, as it allows of the cheapest and most certain transfer of electricity to great distances, and as the water-power is sufficient for probable futurity, so that the disadvantage of this system—the inability of storing up the power directly in accumulators—does not come into consideration.

For the turbines, the total flow of the river Amper is used. The lateral sluices, the shoots of which are moved by the water-power, serve both for a waste course and for a transit through flow.

The machine-house contains three turbine chambers, and close to them a spacious hall for the dynamos, as well as workshops and dwellings for the mechanics.

The installation of turbines, comprising two, and afterwards three turbines, with a common transmission, was entrusted to Schelsam & Issmayer, of Munich. The regulation of the turbines is effected by opening plates and a slide, movable by hand; and, on the other hand, by an automatic brake regulator, which at once loads the turbine if the dynamos are consuming but little power, and thus prevents an increase of speed.

Two alternating current machines, with their exciters (Brown, Boveri & Co.), are driven by bands from the transmission. The machines are each designed for 38,000 watts at 2,600 volts. The two alternating current machines can be introduced parallel. The instruments and apparatus required for this purpose, and for controlling the performance of the machines, are grouped on a switchboard. The principal mains, 7 kilometres long, consist of two copper wires of 6 mm. in diameter, secured to ordinary insulators. The tension of the primary lead at Fürstenfeld-Bruck is to be 2,400 volts, that of the secondary lead 100 volts. For a control of this working tension there is a double main looped back to Schöngeising, which is also used for the telephones. The lead for measuring and telephoning is fixed on the same posts as the high tension lead, and in spite of the electrostatic and electro-dynamic induction of the high tension alternating current, allows the telephone to be distinctly audible. The line installation has been carried out with the co-operation of the telephone inspector, Beringer.

From the boundary of the parish, the high tension lead is conveyed on specially high masts or iron pillars over the roofs of the houses to the transformer rooms, which are distributed in 10 different places.

The transformers are partly enclosed in special huts and partly in small, well-secured rooms. The lead to the transformer is effected through a connecting box, which contains both a cut-out and a lightning conductor.

The transformers are placed in boxes filled with oil.

A secondary net of leads has been laid down at Fürstenfeld-Bruck, which is advantageous, as relatively small domestic installations are concerned. It consists of two wires of 6 mm. in thickness, secured to posts fixed on the roofs, and enclosing the fronts of all the houses. There is no danger to the public even on direct contact with the wires. No disfigurement of the streets is occasioned by these two wires, and it cannot be seen that any disadvantage can arise from these aerial leads. On the other hand, it has the advantage that it is about six times less expensive than cable leads, and that the connections for private consumers cost only about 20 marks per house, whilst the connection with underground cables costs about 200 marks per house. This extremely great economy, which may be effected in small towns by means of aerial leads, renders it possible to supply them with electricity at least as cheaply as large towns with a dense population of consumers.

The domestic installations are executed very substantially. Care is taken, by means of switches, that rooms, passages, and cellars are illuminated from without before being entered. In bedrooms, either bed-lamps or faint night-lamps can be kindled by simple pressure.

The arc lights are connected with small transformers, so that they may be used even singly, without loss.

Electro-motors have come into frequent use, such as C. E. L. Brown's one-phase alternating motor. It consists of a magnetic star, which rotates within a fixed alternating current armature. The current required to excite the magnets is derived from one of the bobbins of the keeper, which has a tension of a few volts only. It is converted into continuous current by a commutator. The electromotors are started, in order to avoid sudden fluctuations of the current, by means of a transformer, which effects the derivation of a current of gradually increased tension by the successive introduction of resistances.

In normal work the motor acts without formation of sparks, and without noise. It bears, without stopping, overloading up to 100 per cent., and it does not require any displacement of the brushes for different loads.

As for the capacity of the entire installation, 120 H.P. are available on the first construction (two turbines on the shaft of the dynamo), and on its completion, 180 H.P. (with three turbines). The efficiency of the dynamos may be taken at 90 per cent.; that of the leads and transformers at 82·5 per cent., so that the maximum efficiency of the entire installation is equal to 1,950 normal lamps. The public lighting requires 5 arc lamps and 80 glow lamps.

The expense of the water power installation affords no basis of comparison for the utilisation of water power in other places.

The cost of the electric installation, exclusive of street lamps, is 59,000 marks for the first installation, or 80,000 marks on completion, *i.e.*, 37 to 33 marks per 16-candle lamp.

This cost must be regarded as very low if we consider that the power had to be conveyed for a distance of 8 kilometres, and that the net extends over the entire town, so that the smallest houses may at once obtain current.

The working cost is composed of the interest and sinking fund, the slight outlay for lubrication and materials for cleaning, and wages for attendance.

There are two turbine keepers at Schöngeising, who release each other in 8-hour shifts, and an overlooker at Bruck.

The total working cost, including interest and sinking fund and a reserve for unforeseen events, are 20 marks yearly for a 16-candle lamp if 1,200 lamps are in simultaneous use. But if the installation is in full use, the cost will fall to 13 marks yearly per normal lamp.

The tariff is, accordingly, for a 16-candle street lamp, on the assumption that half the lamps are extinguished at 11 p.m., burning 2,500 hours yearly, 0·8 pfennig hourly.

For private lighting, used for at least 800 hours yearly, 2·5 pfennig hourly for a 16-candle lamp; for a 10-candle lamp, 1·6 pfennig; and for a 5-candle lamp (fit for passages, kitchens, &c.), 0·8 pfennig hourly.

In consequence, the light has been introduced even into the smallest houses. In all 70 houses are connected, and 1,500 glow lamps, 7 arc lamps, and 12 motors have been installed.

REPORT OF JOINT COMMITTEE ON ELECTRIC POWERS.

THE committee have heard all the witnesses tendered by the several parties, and have agreed upon the following clause, to be inserted in all bills and provisional orders which authorise the undertakers, other than electric lighting undertakers, to use large electric currents, viz.:

Clause to be inserted in all Bills and provisional orders which authorise any company, corporation, or person, collectively referred to as "the undertakers," to use larger electric currents for other than electric lighting purposes. (Some modifications of form may be required to meet the circumstances of particular cases.)

1. The undertakers shall, in the use of electric power under the provisions of this Act [Order], employ either insulated returns or uninsulated metallic returns of low resistance. [This clause not to apply in the case of railways, tramways, or tramroads in which the motive power is entirely self-contained.]

2. The undertakers shall take all reasonable precautions in constructing, placing, and maintaining their electric lines and circuits, and other works of all descriptions, and also in working their undertaking so as not injuriously to affect, by fusion or electrolytic action, any gas or water pipes, or other metallic pipes, structures, or substances.

3. The exercise of the powers by this Act [Order] conferred with respect to the use of electric power, shall be subject to the regulations set forth in the schedule to this Act [Order], and to any regulations which may be added thereto or substituted therefor, respec-

tively, by any order which the Board of Trade may, and which they are hereby empowered to make from time to time, as or when they may think fit, for regulating the employment of insulated returns or of uninsulated metallic returns of low resistance, for preventing fusion or injurious electrolytic action of or on gas or water pipes, or other metallic pipes, structures, or substances, and for minimising, as far as is reasonably practicable, injurious interference with the electric wires, lines, and apparatus of other parties and the currents therein, whether such lines do or do not use the earth as a return.

4. The undertakers using electric power contrary to the provisions of this Act [Order], or to any of the regulations set forth in the schedule to this Act [Order], or to any regulation added thereto or substituted therefor by any order made by the Board of Trade under the authority of this Act [Order], shall, for every such offence, be subject to a penalty not exceeding £10, and also in the case of a continuing offence to a further penalty not exceeding £5 for every day during which such offence continues after conviction thereof: Provided always, that, whether any such penalty has been recovered or not, the Board of Trade, in case in their opinion the undertakers in the use of electric power under the authority of this Act [Order] have made default in complying with the provisions of this Act [Order], or with any of the regulations set forth in the schedule to this Act [Order], or with any regulation which may have been added thereto or substituted therefor as aforesaid, may by order direct the undertakers to cease to use electric power, and thereupon the undertakers shall cease to use electric power, and shall not again use the same, unless with the authority of the Board of Trade, and in every such case the Board of Trade shall make a special report to Parliament notifying the making of such order.

5. The undertakers shall take all reasonable and proper precautions in constructing, placing, and maintaining their electric lines, circuits, and other works of any description, and in using their electric lines, circuits, and other works, so as not injuriously to interfere with the working of any wire, line, or apparatus, from time to time used for the purpose of transmitting electric power, or of telegraphic, telephonic, or electric signalling communication, or the currents in such wire, line, or apparatus. Provided always that the undertakers shall be deemed to take all such reasonable and proper precautions as aforesaid, if and so long as they adopt and employ, at the option of the undertakers, either such insulated returns or such uninsulated metallic returns of low resistance, and such other means of preventing injurious interference with the electric wires, lines, and apparatus of other parties, and the currents therein, as the Board of Trade shall direct, and in giving such directions the Board shall have regard to the expense involved, and to the effect thereof upon the commercial prospects of the undertaking. Provided also that at the expiration of years from the passing of this Act [Order] nothing in this subsection shall operate to give any right of action in respect of, or to protect any electric wires, lines, or apparatus, or the currents therein, unless in the construction, erection, maintaining, and working of such wires, lines, and apparatus, all reasonable and proper precautions, including the use of an insulated return, have been taken to prevent injurious interference therewith, and with the currents therein, by or from other electric currents. If any difference arises between the undertakers and any other party with respect to anything in this subsection contained, such difference shall, unless the parties otherwise agree, be determined by the Board of Trade, or at the option of the Board by an arbitrator to be appointed by the Board; and the costs of such determination shall be in the discretion of the Board, or of the arbitrator, as the case may be.

6. Nothing in this section shall apply to the use of any electric line, circuit, or work of any company, corporation, or person authorised by Act of Parliament, or provisional order confirmed by Parliament, to supply energy for electric lighting purposes, so far as such use is limited to such purposes.

The committee have also agreed upon the following resolutions in the nature of recommendations, viz.:—

1. The committee having regard to the evidence before them, are of opinion that it is not, in the present state of electrical science, to the interest of the public to insist upon electrical tramways using an insulated return conductor, and that such insistance would retard the development of electric traction.

2. The chief objections which have been urged before the committee to an uninsulated return conductor are, first, the interference by leakage and induction with telephones; secondly, the interference by leakage and induction with railway signals; thirdly, the damage to systems of gas and water pipes by the action of leakage currents.

3. They are of opinion that the best known means of overcoming the first of these disturbances is by providing an insulated return conductor for the telephones, and they have the less hesitation in recommending this course, as the evidence shows that telephone construction is already tending in this direction, and that better results are secured to the public by the use of a twisted metallic circuit insulated entirely from the earth.

4. The second objection deserves serious consideration on account of the danger to the public, but the committee are of opinion that the disturbance may be remedied at comparatively small expense by the adoption of an insulated metallic return by the railway companies.

5. They consider that, although electric tramway and electric railway companies should be allowed to use the wheels of carriages and the rails to complete the electric circuit, the currents should be produced and used in such a manner as to mitigate, as far as is practicable, any injurious effect to telephonic communication.

6. The committee are of opinion that it is desirable in every way to facilitate the use of complete insulated metallic circuits for telephones, and for this end they recommend that statutory powers be granted enabling telephone undertakers to lay their wires underground.

7. The danger from fusion or electrolytic action appears to the committee to have arisen from a faulty system of constructing electric tramways, and they are of opinion that it can be reduced by improved methods of construction, so as to be practically negligible.

8. The committee therefore recommend that the Board of Trade shall, in virtue of the powers to be conferred upon them by each Act or Order, make regulations to secure the best system of working electric tramways and railways, having regard to the expense involved by the carrying out of such regulations, and to the effect thereof upon the commercial prospects of the undertaking. The regulations to provide, *inter alia*:—

(*a*) That a return conductor, if in contact with the ground, shall be of such section and resistance, as to have no difference of potential sufficient to set up injurious leakage currents in the earth.

(*b*) That, both with regard to the structure of the line, and to the method of generation and use of electrical current, everything shall be maintained up to the standard required by the Board of Trade; but if the regulations are altered after the use of electric power on the line has been sanctioned, the undertakers shall not be required to alter the structure or method of working of the line to conform to the more recent regulations, except for the public safety, or unless it shall be proved to the satisfaction of the Board of Trade that any system of metallic pipes or structures is being injured by the action of electricity escaping from the conductors, or for purposes other than public safety, or injury to pipes or structures which the Board may think right, provided that the alterations do not in such last case cause substantial additional expenditure.

(*c*) That all such electrical tests shall be applied to the line by the undertakers as the Board of Trade may think necessary, and that a record of these tests shall be kept for the information of the Board of Trade.

(*d*) That the Board of Trade shall have all reasonable facilities for making any tests they may think necessary, in addition to those recorded by the undertakers, to enable them to ensure the maintenance of satisfactory conditions.

9. That the committee regards with apprehension a large extension of the system of overhead wires in crowded centres.

10. It appears to the committee to be just that undertakers proposing to use large currents should be required to give ample notice to those using small currents, to enable them to protect themselves by insulation, and that with this view, and in reference to the clause agreed upon, a period of two years may fairly be allowed to telephone and telegraph companies from the date of passing of any Act [Order].

LEGAL.

BLACKIE *v.* THE ELECTRICITY SUPPLY CORPORATION.

WE announced briefly, last week, that another action for vibration had been taken against the Electricity Supply Corporation. It was an action brought by a clockmaker, carrying on business in the Strand, for damages and an injunction restraining the defendants from carrying on their business so as to cause a nuisance, before Mr. Justice Cave and a special jury. The defendants' premises are situated in Bull Inn Court, Strand, about 150 feet from the back of the plaintiff's shop. The defendants' machinery consists of ten engines and dynamos, five of which are of 200 horse-power each. Two engines are in the basement on cement concrete foundations 6 feet thick. The other engines rest upon the floor of the building, constructed of iron girders supporting a bed of concrete 3 feet thick. The floor is supported by iron stanchions resting upon concrete foundations let into the ground, 6 feet thick. The defendants at the busiest time of the day work four of the engines and dynamos, producing a current of from 2,000 to 3,000 ampères at a pressure of 100 volts. The plaintiff was called in support of his case, and stated that he first felt vibration in his premises in September, 1891, which he attributed to the working of the defendants' engines. The vibration affected his regulator so that he had to send his watches and chronometers to be regulated elsewhere. The housekeeper and his wife were also called, and bore out the plaintiff's statement. Other witnesses from the neighbourhood were called and said they had felt vibration which they thought came from the defendants' works. For the defence witnesses were called who had visited the plaintiff's premises, and stated that vibration was not felt in the house, but only on the roof, which was only appreciable by means of the most sensitive instruments.

MR. JUSTICE CAVE, in summing up, said that when a person made use of his land in a way differing from others round about he must take care not to inflict injury or discomfort on others. In this case the defendants clearly were not doing what people all round were doing. The test was, had the defendants done anything which had made the enjoyment of the plaintiff's house uncomfortable, or had they seriously interfered with plaintiff carrying on his business? If either had happened, then the plaintiff was entitled to a verdict. If neither had happened, then the defendants were entitled to a verdict. It was said that the defendants had communicated vibration to plaintiff's property. If they had done that so as to substantially interfere with his comfort, or his business, then the plaintiff would be entitled to a verdict. The plaintiff had two strings to his bow—first, an alleged interference with his comfort; secondly, an interference with his business—namely, that his regulator was affected, and he had to get his watches regulated elsewhere at considerable cost. It was not easy to make out what damage had been suffered.

The jury found that there was vibration, but that the vibration was so slight that the damages were inappreciable.

The learned JUDGE held that was a verdict for the defendants, and judgment was entered accordingly.

EDISON UNITED PHONOGRAPH COMPANY *v.* DUNNE.

IN the Chancery Division of the High Court of Justice, on Saturday, the 15th inst., Mr. Justice North on a motion for judgment in default of defence, made an order restraining the defendant from infringing the plaintiff's patent, and directed the taking of an account of profits. His lordship also ordered the delivery up of infringing instruments.

CORRESPONDENCE.

Relative Safety or Danger of Electric Light Currents.

Having already occupied a considerable space in the REVIEW in the recent discussions upon this interesting subject, it was not my intention to encroach further upon your valuable space, thinking from the pointers thrown out by me, and the various valid reasons given against the application of alternating currents being used for electro-medical and electro-surgical operations, I considered my mission at an end, fully expecting the subject would have been followed up by other experts having experience in connection with the science; but as no one (including Messrs. Lawrence & Kirk) has refuted my arguments, I think I may now consider that my views are generally shared in by the majority of your readers, and I should not have opened the subject again had not Messrs. Lawrence & Kirk drifted away from the scientific to the personal side of the question, hence I feel constrained to reply to these gentlemen, who, I have no doubt, in the long run will also become converts to the systems urged by me, maintaining, as I still do, that they are the best, safest, cheapest, and most convenient for the average practitioner to adopt in connection with electro-medical work, the merits and safety of which no one disputes; hence, I think, I can claim that I have gained all my points. However, I may just say that it is to be regretted when scientific men, unable to agree because opinions differ, that they should attempt to slide out of an important discussion through the wave or vent-peg of vituperation which Messrs. Lawrence & Kirk are attempting to do. I may say I have no desire to be satirical, but the arguments of Messrs. Lawrence & Kirk in favour of alternating currents have been extremely weak, in fact, they admit that they do not recommend their use for cautery or galvanic purposes, &c., but in fact actually propose the very methods recommended by me as the best and most reliable, which I venture to say is three points in favour of my arguments; I may also say alternating currents are certainly not suitable, (with a 96 per cent. resistance) for working two and four volt lamps with delicate filaments, or even laryngoscopes for throat examinations (for which a few batteries will suffice and are better adapted), hence, I fail to see what advantage is to be gained by urging the use of high potential currents; nor do Messrs. Lawrence & Kirk give any valid reasons why they should be used. I have read and minutely examined their contributions, and cannot find that they have added one "iota" to either the practical or scientific knowledge relative to the subject under discussion. I will, therefore, leave that part of the matter which relates to their satirical remarks as to my knowledge of the subject to evaporate and melt away as ice before the heat of a scorching July sun, and proceed to argue the scientific points and questions asked; and I may as well take this opportunity to inform those gentlemen that I rarely ever waste my time in wading over text books upon therapeutical matters, for, as a rule, I find most of them a mass of theoretical gibberish which rarely ever coincide with actual facts. I, therefore, prefer to dive into the practical part of the subject and would inform Messrs. L. & K. that I have been a manufacturer of electro-medical and electro-surgical apparatus for the past eight years, during which time I have tackled some difficult problems relating thereto with success, and if they will refer to Dr. Woodward's popular "Treatise on Medical Electricity" published by Simpkin, Marshall as far back as 1885, they will find particulars and illustrations of numerous appliances specially designed by me for this work. I, therefore, claim to have some knowledge of the subject as well as they; at the same time I am not above learning, and, moreover, I am always ready and willing to take up the sale and supply of any improved electro-medical appliance which has any points of real merit to recommend it, and if Messrs. L. & K. can only convince me that the "L. & K." current controller, of which they have said so much about, is in any way more scientific or superior to the "Bailey" water resistance, which is so suitable for electric baths, or the "Veter" carbon rheostat for delicate electro-surgical operations, which are the two standard appliances I always recommend to physicians and medical men, I will most willingly shelve the latter and take up the sale of the former for future operations, and with this view I would say that I have sent them, through the editor, specimens of the "Bailey" and "Veter" current controllers for inspection, and if Messrs. L. & K. will follow suit by sending me a sample of theirs, I will promise to test it gratuitously and give, through the REVIEW, my candid opinion as to the merits of their invention, and in the meantime I would ask them to do likewise with the instruments I am sending them for that purpose, and by this means probably some good may yet come out of this animated discussion, and recorded in the REVIEW, for the benefit of the electro-medical specialist, hundreds of whom, in all parts of the United Kingdom, are seeking and require information of this class.

Messrs. Lawrence & Kirk ask is there any risk from outside causes? I proved this and gave several valid reasons in my letter which appeared in the REVIEW of June 2nd. I will now enlarge upon this, and also include inside causes as well where alternating current or high potential currents are used. Outside dangers can arise from accidental crossing of leads, insufficient or faulty lighting conductors, badly constructed transformers, heavy rainfalls, leakage of mains, &c., &c., and amongst some of the dangers to be met with from the inside may be enumerated the following:—1. Excessive flow of uninterrupted current. 2. Sudden shocks to nervous patients. 3. Variable changes in the periodicity of current. 4. Unreliability of fuses and magnetic cut-outs. 5. Corrosion of wires. 6. Accidental contact with gas or water pipes, &c., none of which dangers can arise or be feared by the wise doctor who adopts the use of chemical currents, as these are known from long experience to be absolutely safe for all purposes; and as neither alternating or high potential currents are suitable for cautery, gynecological, neurological electro-therapeutics or surgical operations, I fail to see why electricians should go out of their way to introduce elements of danger when they can be safely avoided, and I advise all medical practitioners to provide themselves with one of the modern electrical cabinets fitted with the "Law" standard cells, which, owing to their low internal resistance and guaranteed long life, is undoubtedly the best and most suitable open circuit battery for physicians and dental surgery use.

I could say more, but I think I have said enough to show the fallacy of attempting to utilise alternating currents, if danger is to be absolutely avoided. Apologising for this long letter, but as the mattter is of national importance to the public at large, this must be my excuse for going fully into the "pros and cons" of the whole subject relative to the matter in question.

Arthur Shippey.

July 12th, 1893.

High Frequency Experiments.

Referring to your notice of the oil and water experiments recently exhibited by myself at the Royal Society, I should like to be allowed to point out an error in the report.

The bubbling or boiling only takes place with oil, alcohol, and other similar fluids, while with water the surface of the liquid is not disturbed, but an octopus discharge of bright sparks takes place over the surface of the water, leaving the wire at the point where the latter intersects the surface.

While on this subject I should like to ask Mr. E. C. Rimington, whose communication in your issue for the 7th inst. I have read with interest, how he calculates the figure of 400,000 which he gives as the approximate frequency that I obtain. I was recently assured by two most eminent authorities that owing to the great complexity of the obtaining conditions it was quite hopeless to attempt the calculation of the frequency, even approximately. Perhaps the frequency is much higher than Mr. Rimington imagines.

A. A. C. Swinton.

July 17th, 1893.

Gas Engines for Electric Lighting.

Apropos to your references in several of your recent issues to the use of gas engines for electric lighting purposes, particularly in connection with central station work, &c., it may interest you to know that we have on hand at the present time and in progress of manufacture, three gas engines of 120 horse-power each for the Coatbridge Central Station, also a special engine of 100 horse-power for the Rugby School lighting, and another special gas engine which is intended for mill work, which is to indicate about *650 horse-power*. This latter, which is well advanced, will doubtless represent the largest single gas engine in the world, while by duplicating cylinders, &c., there will be no difficulty in constructing engines of 1,000 or 1,200 horse-power. For electric lighting works, however, the writer is of opinion that engines from 250 to 500 horse-power will be found most suitable and convenient to handle, and the best for sub-stations, working with cheap producer gas supplied from a central depôt.

With the cheap gas plant we supply I find the average consumption of fuel is considerably under one pound of coal per horse-power per hour, and my experience is that the labour required in attention to the plant and engine is no more than for ordinary steam plant. Extra lubricating oil is required, but, compared with the economy effected in fuel, this is a small item.

Hy. T. Crewe.
(MESSRS. DICK KERR & CO., LTD.)

July 17th, 1893.

ELECTRO-CYANIDE GOLD EXTRACTION.

WE briefly mentioned last week that the directors of the Universal Gold Extraction Syndicate had given an exhibition of their process of extracting the precious metal from the ore. The details of the operation and a description of the apparatus (Hannay's patent), may be seen in the *Mining Journal* for July 1st of this year.

There appear to be three patents granted to Hannay. The first, No. 14,061, 1886, refers to the use of cyanide and chlorine, of anodes and cathodes separated by diaphragms, but it is not the one recently referred to at the Institution of Mining and Metallurgy. The two remaining patents are No. 14,966 of 1890, and No. 19,181 of the same year.

The use of electricity and cyanide with an agitator is not new; Rae, in 1867, specification No. 61,866, in America was the first to treat ores by the action of electricity and cyanide, and he stated that by the combined action of electricity and chemicals, the metal contained in the ore is first reduced in a state of solution and deposited in a pure state. In a second patent, No. 62,776, March 12th, 1867, Rae added to his apparatus an agitator. In a specification, No. 61,826, 1867, he had already described a vertical shaft to impart rotary motion to the cyanide solution and the ore. A patent was also granted to Rae, No. 12,932, February 5th, 1872, describing a voltaic amalgamator, but we do not remember how it was worked, but surely cyanide was used?

There have been several patents worked for the extraction of gold by amalgamation and cyanide, and Beer's, No. 244,028, July 12th, 1880, begins by this statement in his specification: "I am aware that cyanide has been tried in amalgamating processes; the clean or free gold will combine readily with mercury, without any aid, but that which is contaminated with sulphides and sulphurets is much benefitted by the cyanide treatment."

In patent No. 14,966, 1890, Hannay refers to No. 14,061, 1886, and says that by agitation he can dispense with chlorine. The agitator is not new; its shape has been adopted in several amalgamators.

The great drawback of agitation is that in mining districts where thousands of tons have to be treated, it is a serious item of expenditure to agitate the mass of ore and also of water; besides, it is contestable that agitation is advantageous.

Porous partitions, such as asbestos, are mentioned in Hannay's specifications, but this is simply absurd.

A carbon anode is described, and as carbon is more readily destroyed by cyanide than in a chloride solution, some doubts may be entertained about the value of such anodes, even assuming that the carbon is not worn out by the constant rubbing of ores.

If a metallic anode is used, of what metal will it be made? A 2 per cent. solution of cyanide is a great deal too much, as it represents 20 kilos. cyanide per ton, and 20 tons per 1,000 tons of ore.

Is it a 30, 40, 80 or 90 per cent. cyanide which is used; the price of cyanide varies according to its strength.

In patent 19,181, 1890, a large quantity of mercury is required; the electrodes are not placed in such a manner that the electrolysis is facilitated. What would be the size of carbon anodes in large vats?

How long will these carbon anodes last?

As to the sort of carbon used, the well-known mixture of powdered plumbago and bitumen, is it really a splendid conductor?

We are under the impression that a cyanide process, similar to that of Mr. Hannay's, was tried some three or four years ago, but the inventor was compelled to abandon the mercury cathode, because, no matter the agitation, the weight of the ore broke up the mercury, the loss of which was very great. The statement that the cyanide can be used over and over again is surely misleading; as soon as one starts with sulphides, there is in one way or the other, a formation of sulphuric acid, and the cyanide is decomposed and free hydrocyanic acid is evolved; therefore there must be a loss of cyanide. This is why Simpson (U.S. patent 323,222, of 1885), who used cyanide before Mac Arthur and Forrest and Hannay and mentions the use of cyanide in combination with electricity, was putting carbonate of ammonia in his tank so as to prevent the formation of hydrocyanic acid before dissolving gold by cyanide.

At present, the cyanide process is worked without electric current in tanks, the capacity of which varies between 40 and 150 tons of ore. What is the prospect of success of Hannay's apparatus, which does not seem fit for treating large quantities; for, under the conditions described in the two specifications, the action of the electric current seems to be very weak. How can one know that the ore has been exhausted?

It would be desirable to have the analysis of the different ores treated by this process. What surprises us is, that Mr. Hannay speaks of the absence of copper in his solution when he treats pyrites; and with regard to the same chemicals which are used over and over again, this statement is simply the height of exaggeration.

NOTES.

Telegraphy and Telephony in France.—Some special telephonic systems, charging per conversation, have just been established at Méry-sur-Oise, Nevers, Savigny-sur-Orge, Henonville, Sandricourt Bue, Croissy, and at Chaton. New telegraph offices have also been established at Ormes, Bouxières, Seyssinet, and Saint-Vincent.

Electric Traction at Paris.—It is proposed to establish more electrical tramways at Paris, worked by accumulators. The first will be composed of three cars, and will run from the Place Saint-Augustin to Vincennes; the second will start from Neuilly, and proceed to Saint-Ouen. A special charging station, with Farcot steam engines and Desrozier's dynamos will be established at the tramway depôt.

Insulation Resistance.—M. Carpentier has introduced a new ohmmeter for measuring directly up to half a megohm, or to five megohms with an auxiliary shunt. The instrument, which takes the form of a D'Arsonval galvanometer, has two coils at right angles to each other, pivoted on a single shaft. The battery is replaced by a magneto-machine, the armature of which is drum-wound in eight sections. Otherwise the arrangement and method appears to be the Ayrton and Perry ohmmeter over again. The difficulty in providing a portable apparatus for measuring D.R. is greatly a matter of the standard resistance which it involves. There would scarcely be need for an ohmmeter if a cheap and certain high resistance could be manufactured.

Projecting a Periodic Arc.—Prof. Dechart, in a recent lecture at Vienna, rotated a disc with openings in it before an arc lamp in a projecting lantern. If the openings passed the lamp at a rate non-synchronous with the alternations of the supply current, the successive phases of the current could be seen on the screen at a much lower rate, the projection of the arc appearing as if the frequency was very low. The various periodic stages of the arc were thus clearly shown, and could be readily examined. In another experiment he passed an alternating current through a thin stretched wire, which cools quickly and is tuned to correspond with the alternating current. The wire vibrated and was darkest at the point of greatest vibration, and bright at the nodes. A short note of this experiment is given in a recent issue of the *Electrical World* of New York.

Photo-Electric Photometry.—Messrs. Elster and Geitel have shown that the dispersion of negative electricity from a zinc plate at a constant electric density is proportional to the intensity of the light which is incident upon it. This is taken as the basis for a new method of comparing the intensities of various sources of light. Zinc is found to be unsuitable for the larger wave-lengths, and they now use a surface of potassium in a glass vessel. An electrode of platinum or aluminium is placed opposite the sensitive surface, and is connected to the positive pole of a battery of 100 or 200 volts. The sensitive plate is connected to the negative pole. A galvanometer in the circuit is regulated so as to give no deflection when the plates are in darkness. There is, however, a deflection produced when the light is allowed to fall upon them. These experiments are described in *Wied. Ann.*, Vol. xlviii., No. 4. A short abstract is given in the *Electrical World* of New York. There seems to us but little advance in these results over those of M. Becquerel, or Prof. Minchin, as regards the possibility of photometry by electrical methods of measurement.

The Inventor of Gutta-Percha Covered Wire.—Mrs. E. H. Danchell, in a recent letter to the *Engineer* on this subject, gives the following facts :—"On March 19th, 1845, Mr. F. Wishaw, the secretary of the Society of Arts, read a paper upon gutta-percha before that society, and exhibited specimens of that material in the raw state, and moulded into various shapes by himself. This, then, was probably the occasion at which both Mr. William Siemens and Mr. Danchell obtained samples, and the former sent it to his brother, Mr. E. W. Siemens, at Berlin, while my husband at once conceived the idea of applying it as an insulating material for telegraph wires, and succeeded in doing this, and then started for Berlin. My husband thus spent money, time, and brains, and solved the problem, while no statement is forthcoming of Mr. E. W. Siemens having done so till 1847. It appears that gutta-percha already then, that is in 1845, through a Dr. Montgomerie, of Singapore, had become known to a few in London, for there are the following British patents at this time, viz. :—Brooman, dated March 11th, 1845, No. 10,550, for preparing gutta-percha by purifying, masticating, and mixing it with sulphur, rubber, French chalk, &c. Brooman, dated March 27th, 1845, No. 10,582, for making it into thread. Nickels, May 20th, 1845, No. 10,673, for applying it to book covers, writing cases, &c. Bewley, dated September 4th, 1845, No. 10,825, for moulding and pressing it into various shapes, also for lapping it in strips round a core, the edges being joined by heat or solution. His patent specification shows a cylinder with piston and steam-heated die box ; the gutta-percha being pressed through it and around a core bar, or wire, thus coating the wire. He also describes another apparatus for doing the same thing, viz., by means of grooved rolls and a core. His final specification was filed on February 22nd, 1846. Between March 11th, 1845, the date of Brooman's above-named patent No. 10,550, and April 23rd, 1850, the date when Mr. E. W. Siemens applied for his patent for an improved machine for covering telegraph wires—forming, in fact, an improvement upon Bewley's patent No. 10,825, of September 4th, 1845—there are over fifty British patents for treating and applying gutta-percha to a great many purposes, and amongst them is one by Ricardo, No. 12,262, of 1848, for covering telegraph wires with gutta-percha, and one by Barlow and Forster, No. 12,136, of 1848, for the same purpose."

German Insurance Rules.—The German Insurance Companies forbid the use of anything but incandescent lamps for the lighting of accumulator rooms. No burning or glowing bodies are allowed in such rooms during charge. Wooden mouldings are to be impregnated with some decay-arresting substance, and they are only to be used in dry places. An important provision is also made that safety-fuses and their holders must be marked with the normal current, and they must be so made that too large a fuse cannot be inserted. Fuses must blow at twice the normal current. New installations must be started by experts, and all installations are to be annually inspected.

Electric Lighting at Nantes.—A central station is about to be established at Nantes for distributing the electrical energy for about 8,000 10-candle lamps lighted at once. The system of distribution employed is continuous currents with three wires at 220 volts, and accumulators. Two sub-stations will be established, one at the works and the other in the town. The accumulators will be supplied by the Company for the Electrical working of Metals, and each battery will have a capacity of 1,500 ampère-hours. The two batteries will be able to supply during three hours 1,000 ampères at 220 volts. The machinery will include five tubular boilers, and three compound engines, one of 75 H.P., by Weyher and Richemond, the two others, of 120 H.P., from the firm of Voruz, of Nantes. One of these dynamos will give 200 ampères and a voltage of 250 to 330 volts, and the two others 270 ampères under the same voltage. The canalisation will be underground, and enclosed in concrete channels.

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Gas Engines for Electric Lighting.

Apropos to your references in several of your recent issues to the use of gas engines for electric lighting purposes, particularly in connection with central station work, &c., it may interest you to know that we have on hand at the present time and in progress of manufacture, three gas engines of 120 horse-power each for the Coatbridge Central Station, also a special engine of 100 horse-power for the Rugby School lighting, and another special gas engine which is intended for mill work, which is to indicate about *650 horse-power*. This latter, which is well advanced, will doubtless represent the largest single gas engine in the world, while by duplicating cylinders, &c., there will be no difficulty in constructing engines of 1,000 or 1,200 horse-power. For electric lighting works, however, the writer is of opinion that engines from 250 to 500 horse-power will be found most suitable and convenient to handle, and the best for sub-stations, working with cheap producer gas supplied from a central depôt.

With the cheap gas plant we supply I find the average consumption of fuel is considerably under one pound of coal per horse-power per hour, and my experience is that the labour required in attention to the plant and engine is no more than for ordinary steam plant. Extra lubricating oil is required, but, compared with the economy effected in fuel, this is a small item.

Hy. T. Crewe.
(MESSRS. DICK KERR & CO., LTD.)

July 17th, 1893.

ELECTRO-CYANIDE GOLD EXTRACTION.

WE briefly mentioned last week that the directors of the Universal Gold Extraction Syndicate had given an exhibition of their process of extracting the precious metal from the ore. The details of the operation and a description of the apparatus (Hannay's patent), may be seen in the *Mining Journal* for July 1st of this year.

There appear to be three patents granted to Hannay. The first, No. 14,061, 1886, refers to the use of cyanide and chlorine, of anodes and cathodes separated by diaphragms, but it is not the one recently referred to at the Institution of Mining and Metallurgy. The two remaining patents are No. 14,966 of 1890, and No. 19,181 of the same year.

The use of electricity and cyanide with an agitator is not new; Rae, in 1867, specification No. 61,866, in America was the first to treat ores by the action of electricity and cyanide, and he stated that by the combined action of electricity and chemicals, the metal contained in the ore is first reduced in a state of solution and deposited in a pure state. In a second patent, No. 62,776, March 12th, 1867, Rae added to his apparatus an agitator. In a specification, No. 61,826, 1867, he had already described a vertical shaft to impart rotary motion to the cyanide solution and the ore. A patent was also granted to Rae, No. 12,932, February 5th, 1872, describing a voltaic amalgamator, but we do not remember how it was worked, but surely cyanide was used?

There have been several patents worked for the extraction of gold by amalgamation and cyanide, and Beer's, No. 244,028, July 12th, 1880, begins by this statement in his specification: "I am aware that cyanide has been tried in amalgamating processes; the clean or free gold will combine readily with mercury, without any aid, but that which is contaminated with sulphides and sulphurets is much benefitted by the cyanide treatment."

In patent No. 14,966, 1890, Hannay refers to No. 14,061, 1886, and says that by agitation he can dispense with chlorine. The agitator is not new; its shape has been adopted in several amalgamators.

The great drawback of agitation is that in mining districts where thousands of tons have to be treated, it is a serious item of expenditure to agitate the mass of ore and also of water; besides, it is contestable that agitation is advantageous.

Porous partitions, such as asbestos, are mentioned in Hannay's specifications, but this is simply absurd.

A carbon anode is described, and as carbon is more readily destroyed by cyanide than in a chloride solution, some doubts may be entertained about the value of such anodes, even assuming that the carbon is not worn out by the constant rubbing of ores.

If a metallic anode is used, of what metal will it be made? A 2 per cent. solution of cyanide is a great deal too much, as it represents 20 kilos. cyanide per ton, and 20 tons per 1,000 tons of ore.

Is it a 30, 40, 80 or 90 per cent. cyanide which is used; the price of cyanide varies according to its strength.

In patent 19,181, 1890, a large quantity of mercury is required; the electrodes are not placed in such a manner that the electrolysis is facilitated. What would be the size of carbon anodes in large vats?

How long will these carbon anodes last?

As to the sort of carbon used, the well-known mixture of powdered plumbago and bitumen, is it really a splendid conductor?

We are under the impression that a cyanide process, similar to that of Mr. Hannay's, was tried some three or four years ago, but the inventor was compelled to abandon the mercury cathode, because, no matter the agitation, the weight of the ore broke up the mercury, the loss of which was very great. The statement that the cyanide can be used over and over again is surely misleading; as soon as one starts with sulphides, there is in one way or the other, a formation of sulphuric acid, and the cyanide is decomposed and free hydrocyanic acid is evolved; therefore there must be a loss of cyanide. This is why Simpson (U.S. patent 323,222, of 1885), who used cyanide before Mac Arthur and Forrest and Hannay and mentions the use of cyanide in combination with electricity, was putting carbonate of ammonia in his tank so as to prevent the formation of hydrocyanic acid before dissolving gold by cyanide.

At present, the cyanide process is worked without electric current in tanks, the capacity of which varies between 40 and 150 tons of ore. What is the prospect of success of Hannay's apparatus, which does not seem fit for treating large quantities; for, under the conditions described in the two specifications, the action of the electric current seems to be very weak. How can one know that the ore has been exhausted?

It would be desirable to have the analysis of the different ores treated by this process. What surprises us is, that Mr. Hannay speaks of the absence of copper in his solution when he treats pyrites; and with regard to the same chemicals which are used over and over again, this statement is simply the height of exaggeration.

NOTES.

Telegraphy and Telephony in France.—Some special telephonic systems, charging per conversation, have just been established at Méry-sur-Oise, Nevers, Savigny-sur-Orge, Henonville, Sandricourt Bue, Croissy, and at Chaton. New telegraph offices have also been established at Ormes, Bouxières, Seyssinet, and Saint-Vincent.

Electric Traction at Paris.—It is proposed to establish more electrical tramways at Paris, worked by accumulators. The first will be composed of three cars, and will run from the Place Saint-Augustin to Vincennes; the second will start from Neuilly, and proceed to Saint-Ouen. A special charging station, with Farcot steam engines and Desrozier's dynamos will be established at the tramway depôt.

Insulation Resistance.—M. Carpentier has introduced a new ohmmeter for measuring directly up to half a megohm, or to five megohms with an auxiliary shunt. The instrument, which takes the form of a D'Arsonval galvanometer, has two coils at right angles to each other, pivoted on a single shaft. The battery is replaced by a magneto-machine, the armature of which is drum-wound in eight sections. Otherwise the arrangement and method appears to be the Ayrton and Perry ohmmeter over again. The difficulty in providing a portable apparatus for measuring D.R. is greatly a matter of the standard resistance which it involves. There would scarcely be need for an ohmmeter if a cheap and certain high resistance could be manufactured.

Projecting a Periodic Arc.—Prof. Dechart, in a recent lecture at Vienna, rotated a disc with openings in it before an arc lamp in a projecting lantern. If the openings passed the lamp at a rate non-synchronous with the alternations of the supply current, the successive phases of the current could be seen on the screen at a much lower rate, the projection of the arc appearing as if the frequency was very low. The various periodic stages of the arc were thus clearly shown, and could be readily examined. In another experiment he passed an alternating current through a thin stretched wire, which cools quickly and is tuned to correspond with the alternating current. The wire vibrated and was darkest at the point of greatest vibration, and bright at the nodes. A short note of this experiment is given in a recent issue of the *Electrical World* of New York.

Photo-Electric Photometry.—Messrs. Elster and Geitel have shown that the dispersion of negative electricity from a zinc plate at a constant electric density is proportional to the intensity of the light which is incident upon it. This is taken as the basis for a new method of comparing the intensities of various sources of light. Zinc is found to be unsuitable for the larger wave-lengths, and they now use a surface of potassium in a glass vessel. An electrode of platinum or aluminium is placed opposite the sensitive surface, and is connected to the positive pole of a battery of 100 or 200 volts. The sensitive plate is connected to the negative pole. A galvanometer in the circuit is regulated so as to give no deflection when the plates are in darkness. There is, however, a deflection produced when the light is allowed to fall upon them. These experiments are described in *Wied. Ann.*, Vol. xlviii., No. 4. A short abstract is given in the *Electrical World* of New York. There seems to us but little advance in these results over those of M. Becquerel, or Prof. Minchin, as regards the possibility of photometry by electrical methods of measurement.

The Inventor of Gutta-Percha Covered Wire.—Mrs. E. H. Danchell, in a recent letter to the *Engineer* on this subject, gives the following facts :—"On March 19th, 1845, Mr. F. Wishaw, the secretary of the Society of Arts, read a paper upon gutta-percha before that society, and exhibited specimens of that material in the raw state, and moulded into various shapes by himself. This, then, was probably the occasion at which both Mr. William Siemens and Mr. Danchell obtained samples, and the former sent it to his brother, Mr. E. W. Siemens, at Berlin, while my husband at once conceived the idea of applying it as an insulating material for telegraph wires, and succeeded in doing this, and then started for Berlin. My husband thus spent money, time, and brains, and solved the problem, while no statement is forthcoming of Mr. E. W. Siemens having done so till 1847. It appears that gutta-percha already then, that is in 1845, through a Dr. Montgomerie, of Singapore, had become known to a few in London, for there are the following British patents at this time, viz. :—Brooman, dated March 11th, 1845, No. 10,550, for preparing gutta-percha by purifying, masticating, and mixing it with sulphur, rubber, French chalk, &c. Brooman, dated March 27th, 1845, No. 10,582, for making it into thread. Nickels, May 20th, 1845, No. 10,673, for applying it to book covers, writing cases, &c. Bewley, dated September 4th, 1845, No. 10,825, for moulding and pressing it into various shapes, also for lapping it in strips round a core, the edges being joined by heat or solution. His patent specification shows a cylinder with piston and steam-heated die box ; the gutta-percha being pressed through it and around a core bar, or wire, thus coating the wire. He also describes another apparatus for doing the same thing, viz., by means of grooved rolls and a core. His final specification was filed on February 22nd, 1846. Between March 11th, 1845, the date of Brooman's above-named patent No. 10,550, and April 23rd, 1850, the date when Mr. E. W. Siemens applied for his patent for an improved machine for covering telegraph wires—forming, in fact, an improvement upon Bewley's patent No. 10,825, of September 4th, 1845—there are over fifty British patents for treating and applying gutta-percha to a great many purposes, and amongst them is one by Ricardo, No. 12,262, of 1848, for covering telegraph wires with gutta-percha, and one by Barlow and Forster, No. 12,136, of 1848, for the same purpose."

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Secondary Cells.—Herr Streintz, in a recent article to the *Zeit. f. Elek.* on the theory of secondary cells, gives the equation:—

$$E = 1{\cdot}850 + 0{\cdot}917\ (s - s)$$

where s is the density of the liquid, and s the density of water at the same temperature.

Magnetic Thermo-Couple.—M. Chassagny, in some experiments with an iron-copper thermo-couple, discovers that if the iron is magnetised in the direction of its length, the E.M.F. is increased. The effect is said to be independent of the direction of magnetisation in the iron. An account of these researches was recently given before the French Academy of Sciences.

Alternating Current Measurement.—The *Electrical World*, of New York, gives an abstract of a method originally described by Dr. Behn-Eschenburg in the *Elek. Zeitschrift*, June 2nd, for measuring the current strength, voltage and energy, successively with the same instrument. The energy is measured in two different ways, serving as a check on the tests. The instrument used is a Siemens and Halske electro-dynamometer, the coils of which can be connected variously by a combination of three switches.

Condensers.—Mr. Sahulka, in the *Elek. Zeitschrift*, shows how to calculate for producing a given phase-difference in an alternating current circuit by the introduction of condensers. His articles, which include simple formulæ, were finished in the above journal last month. The practical use of condensers for this purpose unfortunately depends upon factors which mere calculations can scarcely decide. Initial cost is one of them, and durability is another. There is need for careful experiments on these points before the value of condensers for transformer and other work can be fairly estimated.

Electrical Sector of the Left Bank, Paris.—There are grave difficulties in the way of the establishment of this sector. We announced recently that M. Naze, after many efforts, had succeeded in forming a company, and that operations were about to commence. M. Naze has drawn up a justification of the delay, with the result that at the sitting of the Municipal Council, July 5th, a discussion arose which was almost fatal to M. Naze, it being suggested that he had failed. A member of the council then referred to the number of shareholders that had come forward, about six or seven, and who had not been able to form a company. This was perhaps the only reason why M. Naze's failure was not formally announced. It was also said that the conditions of the specification of the City of Paris were too hard, and that it would have to be revised. We are now waiting for this revision, which has now been under consideration for some time.

Working Results of the Dessau Gas Station.—We get from the annual report of the gas company some facts as to the working and consumption of material. In 1890 the number of ampère-hours produced was 367,617; it amounted to 462,524 in 1891; there was therefore an increase of 94,907, or 25·82 per cent. In 1890 the number of arc lamps and incandescent lamps was respectively 59 and 3,287; in 1891 it was 62 and 3,365, showing an increase of 5·08 and 2·57 per cent. The mean consumption of gas for the gas motors of the electrical station has been, per effective horse-power: 1890, 750 litres; 1891, 730 litres; 1892, 710·3 litres. The production of 1 ampère-hour at 110 volts consumed on an average:

	1890	1891.	1892.
Gas	182·8 litres	166·9 litres	159·7 litres.
Water	6·0 „	4·8 „	2·9 „
Oil	2·5 g.	2·7 g.	1·2 g.
Cotton Waste...	·2 „	·4 „	·1 „

The Otto gas engine, of 120 H.P., coupled directly with a Fritsche & Pichon dynamo, gave, as the best result during five hours for 1 cubic metre of gas, 994 watt-hours, measured at the terminals of the dynamo with the energy meter; the mean for December was 864·8 watt-hours. The cooling of the gas motor consumes 21 litres of water per horse-power.

Electricity Works of Companies and Local Authorities.—It is computed that new works which have been decided upon will cost £832,000. Of this total local authorities will be responsible for £807,000; joint-stock enterprise will cost £25,000.

Electric Lighting in Manchester.—The engines, boilers, and dynamos at the electric lighting station have been running for the past few days, and have been tested with satisfactory results. Arrangements are being made for the formal opening of the works on an early date. Some 50 shops, warehouses, &c., in and about Market Street, have been coupled to the electric mains, and inquiries and applications with regard to the terms of supply are being received daily. The current was, on Friday afternoon, conveyed to the Town Hall, and turned on in some of the offices.

Circular Ferro-Magnetic Polarisation.—In a recent investigation by E. Hirsch, the effect of temperature upon circular ferro-magnetic polarisation is studied. The starting points of this research were Kundt's experiments on the so-called "magnetisation potential" (*vide Wied. Ann.*, 1884, 23, p. 228; 1886, 27, p. 197) and those of H. Du Bois on the same subject (*vide Wied. Ann.*, 1887, 31, p. 941; and 1890, 39, p. 40). Hirsch examined not only plates of iron, but also of cobalt and nickel, metals which have a close chemical relation with iron. The plates were extremely thin, so as to allow light to pass through them and were prepared by a process of electro-deposition upon a transparent film of platinum previously burnt into a thin glass plate, the latter possessing no double refraction. A zirconium burner was used as a source of light, and Lippich's polarimeter provided a means of measuring the polarisation, whilst an electro-magnet supplied a field of 9,000 C.G.S. units. The transparent metallic plates were subjected to variations of temperature between wide limits, with the result that the ratio of the rotation of the plane of polarisation to the increase of "magnetisation potential" from one side of the film to the other was found to be independent of the temperature within the limits of the "personal error" of observation; in other words, that Kundt's constant, ψ, in the formula $\varepsilon = \psi\ (J \cdot d)$, is independent of temperature.

Lord Kelvin and the Extension of the Electricity Supply in Bradford.—Lord Kelvin has forwarded the following report to the Bradford Town Council:—

I have duly received the printed reports of Mr. Sydney Baynes and Mr. James Shoolbred, and other documents sent to me in accordance with your instructions. I have also had a full discussion of the whole subject in conference with Mr. Baynes and Mr. Shoolbred, and I have since received a chart and some further information from Mr. Baynes. After careful consideration of the whole subject, I now report as follows:—1. In my opinion, the best arrangement for improving and augmenting the electricity supply according to the present limited demand of the committee is that recommended by Mr. Baynes and described in his printed report, according to which a third conductor is brought back to the generating station, and all the adjustments to give proper electric pressure to the consumers are performed at that station. 2. The method proposed by Mr. Shoolbred, whether for a three-wire system or a five-wire system, according to which the adjustments of the pressure for the consumers at different parts of the system are entrusted to automatic mechanism at the feeder ends, is not adapted to give in ordinary circumstances the requisite uniformity of pressure to the consumers, and is liable, also, to serious dangers and objections. 3. I do not think it probable that when the time comes for extensions to greater distances, it will be found advisable to adopt the five-wire system, or to go beyond the three-wire system. 4. It seems to me probable that the best and most economical plan for extending to much greater distances than those covered by the system now in use will be by the establishment of a second generating station in some convenient position at a distance of not more than one mile and a-half from the present generating station. 5. I have carefully considered the question of "simple shunt" or "compound winding" for the balancing motor generator, and although I am informed by Mr. Baynes that compound wound motor-generators are now in use at Southampton, and give good results there, I believe that simple shunt winding will be found to give equally good results in ordinary use, and to be safer in respect to contingencies of possible occurrence.

It gives us unqualified pleasure to find Lord Kelvin approving of Mr. Baynes's plan. We have over and over again urged that Mr. Baynes was quite capable of advising the Town Council, and with this corroboration from Lord Kelvin the council ought to place more reliance on their engineer than they have hitherto felt disposed to do.

The Cost of a Board of Trade Unit.—Southampton central station probably occupies the unique position of turning out the most expensive unit. It costs 1s. 4d., and rumour says it is not over good at that.

A "Manual of Telephony."—We are informed that, with the assistance of Mr. Arthur J. Stubbs, Mr. W. H. Preece, F.R.S., has just finished the preparation of "A Manual of Telephony," which will be published early next month by Messrs. Whittaker & Co.

Roundhay Electric Trams.—On account of complaints in the Yorkshire papers, Mr. Graff Baker has felt it necessary to point out that the line equipped by electric traction was more in the nature of a demonstration of the capabilities of electricity. Had it been otherwise, reserve plant would have been installed, which would have prevented stoppages.

The Continental Edison Company.—An arrangement has been arrived at between the Compagnie Continentale Edison and the Compagnie l'Electro-Mecanique de Pantin, whereby the latter will undertake all the orders of the former. The Edison Company is to introduce in the new undertakings the electrical plant made by Messrs. Brown, Boveri & Co., of Baden, Switzerland. It is said that the American Edison Company has asked Mr. Brown to proceed to the United States to introduce his types of dynamos and alternators, which are to be worked on a large scale in that country.

The Electrolysis of Aqueous Sulphuric Acid.—An interesting study of the electrolytic decomposition of aqueous sulphuric acid has been made by V. Kuriloff, who investigated the quantities of hydrogen peroxide and of persulphuric acid formed when solutions of various strengths were subjected to the action of the current. The apparatus used permitted the examination of the liquids at the two electrodes, and chemical tests were employed. The chief results arrived at were:—(1) The amount of hydrogen peroxide produced during electrolysis is very small; (2) Both the peroxide and persulphuric acid may be formed simultaneously at each electrode, but the former is not always accompanied by the latter; (3) The production of both these substances is intimately associated with the degree of concentration of the aqueous acid; (4) Mixtures of water and acid containing 3·47, and 73 per cent. of the latter respectively, behave differently from other mixtures with regard to the amount of hydrogen peroxide formed when they are subjected to the action of the current.

Sports by Electric Light.—The electric light is being used most successfully by the Montreal Amateur Athletic Association for the illumination of its out-door grounds, so that athletic sports and games may be held at night. These grounds at Montreal, Canada, have a third of a mile track, which is illuminated by 17 arc lamps of 2,000 C.P. each. The lamps are supported by arms projecting from poles, and are directly above the outside of the track. Eight of the lamps are placed along the track in front of the grand stand, which has a length of 730 feet, so as to secure a better illumination of this portion where the sprint and field events take place, and the long distance races finish. The remaining lamps are located at equal distances apart around the other portion of the track. Foot and bicycle races and other sports are now held at night, and can be viewed by the spectators, with the aid of the electric light, nearly as well as by daylight, and without the discomfort of the heat of the sun. Sports by electric light were first tried as an experiment last summer, and with such success, that they have now become a regular institution, and have been introduced at Toronto by the athletic association there. It was found in Montreal that the attendance at night was much larger than when the games were held during the day, and that the increase in the receipts from the spectators more than paid for the cost of the electric light.

Defective Gunboats.—It is said that the *Gossamer*, which was commissioned for the naval manœuvres, is delayed at Chatham through defects in her electrical fittings.

Maritime Congress.—The International Maritime Congress was opened on Tuesday at the Institution of Civil Engineers. Papers were read on coast communication and lighting.

The Age of Belts.—*Clifton Free Press* says that this is an age of electricity, and that Mr. Lonsdale's belts are acknowledged to be the most perfect. Mr. Lonsdale is, we believe, *the* peripatetic representative of *the* profession.

Papers for the International Congress, Chicago.—Dr. Stephen Lindeck, of the Physikalisch Technische Reichsansalt, Berlin, will read a paper on "Materials for Standards of Electrical Resistance and their Construction," and Prof. Silvanus Thompson a paper on "Ocean Telephony."

Use of the Electric Light in Suez Canal.—We have frequently noticed the number of vessels which pass through the canal using the electric light. There is a gain of 12 hours when using the light. In 1890 the percentage of ships with electric light was 83 per cent., in 1891 88 per cent., and in 1892 90 per cent. Electric light apparatus may be hired at each end of the Canal.

Working of Dublin Tramways by Electricity.—A select committee of the House of Commons considered last week the proposals of the Dublin Southern District to use electricity on their system. Mr. Spagnoletti, Mr. Siemens, Mr. Langdon, and other witnesses were examined. Eventually the committee decided that the preamble of the Bill had been proved.

The Position at Windsor.—The electric light company is in an awkward position at the present moment. Plant has been erected and current is being supplied in certain streets, but the company is short of money, and they are unable to carry out the provisions of the order. The Board of Trade has spoken of revoking the order, but Mr. Sydney Morse, solicitor to the company, has shown the Board of Trade that further capital may be found eventually. Thus matters stand at the moment.

Scale of Charges for Bolton.—The Corporation Committee, which recently met to consider the general conditions for supply of electricity within the borough, have decided on the following charges. The current will be charged per quarter at the following rates, per Board of Trade unit, the consumption being per 16 C.P. lamp (or equivalent):—

	Unit.
For above 12½ B.T. units, per 16 C.P. lamp	5½d.
" between 10 and 12½ units, per 16 C.P. lamp ...	6d.
" " 7½ and 10 " " ...	6½d.
" " 5 and 7½ " " ...	7d.
" " 2½ and 5 " " ...	7½d.
" below 2½ " " ...	8d.

Richmond Town Council and their Adviser.—The minutes of the Electric Lighting Committee had reference to the account for £240 sent in by Mr. Shoolbred, late consulting engineer. They were only prepared to pay 100 guineas, being of opinion that this sum was fully equal to what he was entitled to receive under the arrangement come to. It was decided that after consultation with Mr. Smith, who resides at Richmond, and is a member of the firm of Messrs. Urquhart & Small, of Westminster, that this firm should receive the appointment from the present time to the completion of the works, the remuneration being fixed at 100 guineas.

Pure Mercury by an Electrical Process.—For many purposes, especially those of an electrical nature, it is desirable to use mercury of the purest quality; but this metal has the objectionable property of entangling or retaining traces of foreign matters which seriously affect its physical behaviour, and are extremely difficult to eliminate by any known chemical process. Recognising the importance of purity in the metal, W. Jaeger has given the matter much attention, and has succeeded in evolving an electrical process of purification which produces the most satisfactory results. The method is described in detail in the *Ann. Phys. Chem.*, [2], xlviii., pp. 209—212; but its essential features are as follows:—The commercial mercury is first distilled *in vacuo* in a specially constructed apparatus, wherein the use of grease for the taps, or of India-rubber for the connections, is avoided; it is then converted into mercurous nitrate, and deposited electrolytically from a solution of this salt. A platinum electrode serves as a cathode, and a portion of distilled mercury as the anode. A current of 1—3 ampéres, giving from 0·004—0·012 ampère at the cathode, and 0·001—0·003 ampère per sq. cm. at the anode is sufficient. After this treatment the resulting metal showed no trace of impurity when submitted to delicate chemical tests.

The Electrical Conductivity of Metallic Fluorides.—Numerous observations have established the fact that all ferric salts which are electrolytically dissociated give yellow aqueous solutions, whilst those which are only dissociated hydrolytically give solutions which are reddish-brown in colour. But aqueous solutions of ferric fluoride are colourless, and it might therefore be supposed that neither electrolytic nor hydrolytic dissociation played any part in them. R. Speransky has recently concluded an investigation which was undertaken to elucidate this point, and has found that the electrical conductivity of ferric fluoride solutions is so exceedingly small, that it is a fair inference to state that there can be no appreciable electrolytic dissociation. A similar investigation with chromic fluoride and aluminium fluoride showed that if any electrolytic dissociation exist in solutions of these substances, it must be excessively small. Incidentally, Speransky observed that the violet modification of chromic fluoride conducts electricity better than the green modification; he gives no numerical data, however, a fact which depreciates the value of his observations.

Commercial Organic Compounds by Electrolysis.—A distinct advance in the progress of commercial electrolysis having reference to the manufacture of phenol (carbolic) compounds is to be credited to the firm of F. Bayer & Co., of Elberfeld. The periodides of the phenols and the phenol carboxylic acids have been made by subjecting mixtures of the solutions of alkaline salts of phenols and of alkaline iodides to electrolysis, the method being substantially as follows:—A solution of the alkaline iodide is prepared, and in this are immersed the electrodes separated by a diaphragm; the current is then passed through the solution, and whilst the latter is being electrolysed an alkaline solution of the phenol is gradually added. Two ampères per square decimetre of electrode surface is found to be sufficient current strength. In a few hours the phenol is completely converted into the periodide, the latter separating out in the solid form.

White Lead by Electrolysis.—In the *Chemiker Zeitung*, xvi., p. 323, there is an account of an installation for the manufacture of white lead by electrolysis, in which we recognise the following new modification:—Lead anodes, 3 mm. in thickness, are employed in electrolysing the solution, the latter containing 300 cc. of nitric acid in 2,000 cc. of water; the lead salt formed when the current passes is precipitated as true white lead by means of a stream of carbonic acid gas, which is passed through the solution. In this process, any silver which the lead may contain is deposited on the cathodes, and can be recovered in a tolerable state of purity.

Manures and Dying Mordants by Electrolysis.—When a solution of ferrous sulphate, to which a weak solution of the protochloride of iron, sodium, potassium, calcium, vanadium, or magnesium, has been added, a basic sulphate of the peroxide is formed, and the addition of an equivalent of sulphuric acid, either before or after electrolysis, causes the formation of the trisulphate of peroxide of iron—a substance which can be used with great advantage in slaughter houses for the preparation of dried blood manure. MM. Hermite and Dubosc have developed this idea into commercial importance during the past few months. They cause the ferrous sulphate to circulate through an electrolytic apparatus arranged to maintain a maximum proportion of the salt in solution; in this way they obtain a completely saturated solution of the sulphate of the peroxide. By varying the current density and its duration, a greater or less quantity of this substance may be formed, constituting the various dying mordants known as "rust," sulpho-nitrate," and "persulphate of iron." The apparatus in which this is effected consists of an enamelled iron tank, with an outlet at the bottom for running off the contents when required; a perforated pipe in the lower part of the tank for supplying the solution to be acted on, and an overflow outlet in the upper part. The electrodes are plates of iron alternating with thin platinum sheets.

NEW COMPANIES REGISTERED.

Electric and Automatic Engineering Company, Limited (39,260).—This company was registered on the 15th inst., with a capital of £10,000, in £1 shares, to purchase any patents or any other rights for any system or process for the working of automatic supply or other boxes, or kindred boxes or machines worked by mechanical, electrical, or any other power, and for the producing of electric currents, chemicals, or appliances used in connection therewith; to use and develop such patents; and to carry on the business of manufacturers and dealers in chemicals, goods and commodities capable of being used in connection with electricity. The subscribers (with one share each) are:—A. Aylard, Portsea Villa, Manor Park, Essex, secretary; C. Gallagher, 58, Ball's Pond Road, N., clerk; J. Mason, 23, Commercial Road, E., electrical engineer; G. Moffatt, Rochester, gentleman; B. J. Stracey, 17, Setters Street, E.C., gunmaker; J. Wiseman, Worcester, merchant; W. S. Jackson, Forest Gate, clerk. The number of directors is not to be less than 3 nor more than 7; qualification, £100; remuneration, chairman £100, and the other directors £75 per annum each. There will also be a certain percentage allowed on the profits of each year. Registered by A. Aylard, Portsea Villa, Manor Park, Essex.

West Indian Development Company, Limited (39,239).—This company was registered on the 13th inst., with a capital of £5,000, in £1 shares, to adopt an agreement made between J. K. D. Mackenzie and others, to acquire any Act of Parliament, provisional order or license, in relation to conveniences of all kinds in the West Indies and elsewhere, to construct, work, administer, and control piers, wharves, railways, tramways, gas, electric light, hotels, theatres, &c.; to carry on the business of electricians, electrical engineers, builders, and contractors; and to supply the city of Bridgetown, in the Island of Barbados, and the suburbs thereof, with electricity. The subscribers (with 10 shares each) are:—J. K. D. Mackenzie, 15, Redcliffe Square, S.W., engineer, N. A. Sinclair, 11, St. George's Road, S.W., gentleman; C. A. Grant, 29, Elm Park Gardens, S.W., gentleman; E. W. Piper, 37, Vernon Road Bow, accountant; A. W. G. Matthews, 299, High Road, N.W., clerk; G. M. Nicolaus, Queen Anne's Mansions, S.W., gentleman; G. T. C. Edwards, 77, Lyndhurst Grove, Peckham, S.E., engineer. Table A generally applies. Registered by H. F. Kite, 11, Queen Victoria Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Automatic Electrical Corporation, Limited.—The works of this company are closed, and according to a document lately filed at Somerset House, the concern is completely defunct.

Brazilian Submarine Telegraph Company, Limited.—The annual return of this company was filed a short time ago, and shows that out of a nominal capital of £1,300,000, in £10 shares, the whole amount of shares has been taken up. The total amount of calls received equals the nominal capital of the company, viz., £1,300,000.

Callender's Bitumen Telegraph and Waterproof Company, Limited.—The annual return of this undertaking, filed at Somerset House on the 2nd ult., discloses the fact that out of a capital of £80,000, in £10 shares, 6,316 of these have been taken up, with £10 called on each. The total amount of payments received on this account reaches £33,160; and £30,000 has been agreed to be considered as paid.

Birmingham House-to-House Electricity Company, Limited.—The annual return of this company was filed on the 8th of last May, and it appears from this that out of a capital of £100,000, in 19,900 ordinary and 100 founders' shares of £5 each, 107 shares only have been taken up. There has been £500 agreed to be considered as paid.

Allen, Everitt & Sons, Limited.—The annual return of this company was filed at Somerset House on the 29th ult. The original capital of the concern was £300,000, in 10,000 preference and 20,000 ordinary £10 shares, and out of this there have been 10,000 preference and 12,000 ordinary shares taken up, with the full amount paid on 6,700 of the former class, and £8 on 8,000 of the latter. The total sum of calls received is £131,000; and £65,000 has been agreed to be considered as paid.

Benham & Froud Company, Limited.—The annual return of this concern has been lately presented at Somerset House, and shows that out of a nominal capital of £50,000, in £10 shares, 2,907 have been taken up, with the full amount paid on each. The aggregate sum of calls received equals £28,887 10s., and there is still £182 10s. in arrear.

Anglo-Portuguese Telephone Company, Limited.—A short time ago the annual return of this company was filed at Somerset House. The return states that out of a capital of £75,000 in £1 shares, 50,000 had been taken up. There has been nothing called on these shares, but the full amount has been agreed to be considered as paid.

Baily, Grundy & Barrett, Limited.—The statutory return of this company has been filed, and it appears that out of a nominal capital of £10,000, in £5 shares, 602 shares have been taken up. There has been £2,950 paid, and £60 is still outstanding.

Barnet and District Electric Supply Company, Limited.—The annual return of this undertaking has recently been filed. The original capital was £5,000 divided into 490 ordinary and 100 founders' shares, the former of £10 and the latter of £1 each; and up to January 14th last 80 ordinary and the whole of the founders' shares had been taken up. There has been £10 called on 60 of the ordinary and £5 on the remaining 20. The total amount of calls received reaches £700; £100 in respect of the founders' shares has been agreed to be considered as paid.

Cuttriss, Wallis & Company, Limited.—The annual return of this company, filed on the 22nd ult., shows that out of a nominal capital of £10,000, in £5 shares, 771 shares have been taken up. There has been £5 called on each of 351 of these, and the total amount of calls received equals £1,755. A sum of £2,100 has been agreed to be considered as paid on £420 shares.

Davis & Timmins, Limited.—The annual return of this company was filed not long ago, and reveals the fact that out of a capital of £20,000 in £10 shares, 1,303 have been taken up. A sum of £10 has been called on 1,003 of these, and the remaining 300 have been issued as fully paid.

Dick, Kerr & Co., Limited.—The annual return of this company was lately filed at Somerset House, and from it it appears that out of a nominal capital of £160,000, in 16,000 ordinary and 16,000 preference shares of £5 each, the whole of these shares have been taken up. The full amount has been called on the preference, and the total sum received in respect of this is £80,000. The whole of the ordinary shares have been agreed to be considered as paid.

Cambridge University and Town Electric Lighting Company, Limited.—The annual return of this concern was filed on the 10th inst., and shows that out of a nominal capital of £50,000, in £10 shares, only 7 shares have been taken up. There has been no payment made on these.

Devonshire Electric Light and Power Supply, Limited.—The annual return of this concern shows that only seven shares have been taken up out of a capital of £1,000. There has been nothing called on these shares.

Chloride Electrical Storage Syndicate, Limited.—The registered office of this company is now situated at 8, King Street, Manchester.

British Electro-Chemical Agency, Limited.—The registered office of this company has been removed to 16, Great George Street, Westminster, S.W.

CONTRACTS OPEN AND CLOSED.

OPEN.

Blackpool.—For installation of electric light wires, fittings, and lamps in the Town Hall and open market, for the Corporation. Forms of tender and specification can be obtained from Mr. J. Hesketh, borough electrical engineer, Princess Street, Blackpool, to whom tenders should be sent by 22nd inst.

Launceston, Tasmania.—Tenders wanted for the lighting of the city of Launceston, Tasmania. Fuller particulars will be found in our advertisement columns.

Halifax.—Tenders wanted for boilers, engines, and alternators. Further particulars can be obtained in our advertisement columns.

CLOSED.

Dorset County Asylum.—The tender of Mr. F. M. Newton, of Taunton, has been accepted.

BUSINESS NOTICES, &c.

J. A. Berly's Universal Electrical Directory for 1893 (12th year), 784 pp. This standard work contains a larger amount of trade information than any other similar publication, and should be in the hands of every engineer or electrician Free within the Postal Union for 4s.

New Electric Rock Drill.—A new rock drill has been designed by Mr. W. Heyes, of the Corlett Engineering Company The motor is enclosed in a brass case at the base of the drill. The speed of the motor is 2,000 revolutions per minute, its power being transmitted to the drill through two cog-wheels which reduce the number of strokes to about 240 a minute. The drill is also given a slow revolving motion. By a spring arrangement all shock is taken from the drill when the blow is given, thus enabling the motor to work smoothly and without jar.

Utilisation of Sewage for Land.—Electrical experiments in connection with the utilisation of sewage are being carried out at Broughton Farm, Otford, Kent, and are arousing a very lively interest in agricultural communities. Mr. W. S. Freeman, electrical engineer, is conducting the operations. A hop plantation, close to the main sewer, has been placed at his disposal by Mr. Greenlees; and electrical power, generated at Mr. Freeman's works, is transmitted by overhead wires to the plantation. A 6½ horse-power motor works a 3-inch centrifugal pump, and the sewage is forced through pipes to a centre, and then by means of trenches distributed over the area experimented upon. It is claimed that a high fertilising agent is thus obtained at a cost of £1 per acre, or at the rate of 1½d. per ton of sewage. This is a great improvement on the old-fashioned way of land dressing, and is an unobjectionable way of utilising the sewage.

Lighting of St. George's, Hanover Square, Public Library, Buckingham Palace Road.—Below are given the names of competitors, with amounts of tenders, for electric light wiring (India-Rubber Company's 600 megohm, including distribution boards, arranged for 3-wire system; Edison-Swan "tumler" switches, &c., complete, ready to receive fittings):—

Edmundsons, Limited	£325 12
Jackson, A. W.	309 0
Planet Electrical Engineering Co., Ltd. ...	277 0
Strode & Co.	257 0
Drake & Gorham	237 15
Verity, B., & Sons	213 0
Benham & Sons, Limited	177 10

That of Messrs. Benham & Sons was accepted.

Dissolution of Partnership.—The partnership heretofore existing between Messrs. Harold & Jenkins has been dissolved by mutual consent. Mr. H. C. Harold will continue to carry on the general business (excepting electrical stampings and forgings), at 30 and 31, St. Swithins Lane, and will meet all liabilities, and receive all payments in connection therewith. Mr. R. Jenkins will carry on that part of the business of the late firm connected with armature discs, transformer stampings, and magnet forgings, at No. 88, Bishopsgate Street, London, E.C. All payments for forgings due to Harold and Jenkins, are to be payable to "The Magnet Forge," 88, Bishopsgate Street, E.C.

The Difficulty at Chatham.—The Chatham, Rochester and District Electric Lighting Company have now come to a satisfactory arrangement with their chairman, Mr. H. Jasper, whom, it will be remembered, advanced the money (nearly £10,000) necessary for the erection of works and machinery and carrying out the Board of Trade order in consideration of fully paid up shares to the nominal amount of £18,630 being placed to his name. Some of the shareholders did not fall in with the agreement, but the difficulty has been overcome by Mr. Jasper offering to sell any, or all, of the shares allotted to him at the actual price paid for them.

Buying Electric Light Plant.—In the City Court on Monday, Messrs. Foster & Braithwaite, of Austin Friars, sued Mr. Cohen, a metal merchant, for £12 10s. on account for electric light machinery. The defendant bought plant to the value of £22 10s., and he paid £10 on account, but moving the machinery plaintiff's walls were damaged, and a claim was made in consequence. Jury found for the amount claimed.

Croydon too Cautious.—Our note that Croydon were going to spend £25,000 on lighting was wrong. They have not gone as far as that. The General Purposes Committee have over and over again recommended the Town Council to do something definite in the matter of the provisional order, but at the last meeting the question was again referred back to the Committee.

Electrical Engineering at a Bristol School.—Merchant Venturer's School at Bristol can really teach electrical engineering. There are two dynamos built by students of the school; in addition there is a large experimental machine made by the Brush Company, and storage cells and other apparatus incidental to actual lighting work.

The Trouble on American Cars.—The great trouble on the West End railway electric cars is the gentleman who chews tobacco and ———. The Company has received a petition signed by 5,000 Boston ladies asking for a mitigation of the nuisance. The only remedy would be to improve the depraved creature off the face of the earth.

Asylum Lighting.—Mr. F. M. Newton's, of Taunton, tender has been accepted for the lighting of the Dorset County Asylum. The installation will consist of about 1,000 incandescent lamps. "Taunton" dynamos will be used, coupled direct to "Willans" high-speed engines.

The Fares on the South London Railway.—Mr. Byles, in the House of Commons, asked on what grounds the City and South London Railway were privileged to charge more than a penny per mile. It was stated, in reply, that the Inland Revenue did not suffer because the company had to pay duty on each fare.

Aberdeen Increases its Order.—The Corporation originally intended to supply 18,000 lamps. They have thought better of it, and now propose to supply 27,000. Total cost will be under £24,000.

Chelsea Company Extends Operations.—The Chelsea Electricity Supply Company, Limited, have completed the laying of mains and are now supplying current in the following streets, lately added to their area of supply: Cheyne Gardens, Cheyne Walk, Chelsea Embankment, St. Leonard's Terrace, Tedworth Square, Tite Street, Ralston Street, Durham Place, Oakley Street, King's Road. Large additions to plant and further extensions of mains are being made.

Winchester.—The Town Council of the City of Winchester have appointed Messrs. Morgan Williams & King as consulting engineers to adjudicate in the matter of the award of the premium offered for the best scheme for the electric lighting of the city.

Lambeth Vestry and the Electric Light.—The re-appointment of an electric light committee has been postponed for six months. In June of last year the Vestry obtained an order, but if mains are not laid in the principal streets by next June the Board of Trade, if they think fit, may revoke the order.

The Lighting of the Greenock Exhibition.—The Gülcher Company lighted this recently held exhibition, but they were not paid in full. An action was therefore brought against the promoters for balance of account £53. Eventually the payment of £32 10s. to the plaintiffs was agreed upon.

Rental of Transformer Chambers.—The Town Council of Sheffield have thought they would like to charge a rental for the transformer chambers, proposed to be used by the electric light company. The Deputy Town Clerk, however, thinks such a charge would be illegal.

Extension of Lighting.—The London Electric Supply Corporation shows indications of a desire to extend operations. The company has been recently in communication with the Clerkenwell Vestry on the subject of introducing the light into the district.

Electric Light at Guildford.—The Town Council, who will not supply electricity themselves, have no objection to the Holloway Electricity Supply applying for an order, though the matter is scarcely settled yet.

Engineering Sale.—Messrs. Wheatley Kirk, Price, and Co., will sell by public auction on Wednesday next, at the Canal Street Ironworks, Derby, engines, boilers, shafting, steam hammers, machine tools, and plant.

The New Engineer for Hull.—A correspondent to the *Eastern Morning News* suggests that the electric lighting committee should give preference to a high tension man, because low tension will be shortly obsolete.

Provisional Orders Awarded.—Eighteen applications for electric light orders were made during the past twelve months, eleven by local authorities, seven by companies, the rest relating to London. With three exceptions they were granted.

The Theatrephone.—A room is specially set apart for the theatrephone at the Earl's Court Exhibition. Most of the principal theatres are on tap, and numerous visitors patronise the ingenious show.

Electric Light at Shrewsbury.—The Shrewsbury Electric Lighting Company have applied to the Town Council for permission to light the town by electricity. The matter is being considered.

Electric Motors used at Dundee.—The motor is supplanting manual labour at Dundee. They are being used by tradesmen for sawing, mincing, and other purposes. Current is obtained from the town mains.

Another Gas Station.—They are apparently more convinced on the continent of the utility of gas electric stations than we are in England. The latest is at Carignan where a small station has been built for a town supply.

Fire at Manchester Reference Library.—It is said that while Messrs. Verity & Co. were laying electric light wires a spark from a candle carried by one of the workmen set fire to the building. A number of books and a portion of the building were destroyed.

Electric Light at Chatsworth.—Water power is being utilised for the electric lighting of Chatsworth Hall. It is said that 150 H.P. can be obtained. Mr. Bernard Drake is carrying out the work.

Madras Electric Tramway Company.—The Government of Madras has refused the extension of six months asked for by the Tramway Company in which to complete this line. A deposit of 10,000 rupees is thus forfeited to the Government.

Personal.—Mr. Massingham has resigned the position of managing director of the Bath Electric Lighting Company, but retains his seat on the board. Mr. G. F. Metzger, the company's chief engineer, has been appointed general manager.

Electric Light at Moffat.—The estimate of Woodhouse and Rawson for lighting the burgh, at a cost of £4,000, has been accepted. Water-power from a fall two miles distant is to be employed.

Annual Excursion.—The employés of the Kensington and Knightsbridge Electric Lighting Company, Limited, had a most enjoyable day on the occasion of their fourth annual excursion, which took place on Saturday last. Dinner was partaken at the "Elephant Hotel," Pangbourne. Mr. H. W. Miller, the resident engineer at Kensington, was in the chair.

Telephone Litigation.—The American Bell Telephone Company has begun its expected fight to protect its unexpired patents. Two suits are down for hearing in the American Courts.

Birmingham gives Way.—The Town Council is now more kindly disposed towards electric lighting, and it is likely that they will not offer objections to a company obtaining an order.

Electric Light Station at Bromley.—The Local Board are borrowing £3,175, at 3½ per cent., from the Prudential Assurance Company, for the purchase of land for an electric light station.

Tunbridge Wells Decides Wisely.—The Town Council have adopted the committee's recommendations that the Corporation do the lighting themselves. It is expected to cost £13,000.

The Largest Alternating Current Motor.—It is said that the largest motor ever built is being tested at the Hartford Electric Light Company, Connecticut. It is of 300 H.P.

Londonderry Borrows £15,000.—It has been decided by the council to borrow £15,000 for electric lighting purposes, £11,000 to be paid in 25 years, the rest in 16.

Fareham Electric Light Company and the Local Board.—Some differences have arisen about the contract for street lighting. The matter has been postponed.

Change of Address.—The Electric Construction Corporation have left Worcester House and gone to Queen Street Chambers, Queen Street, Cheapside, E.C.

Lighting of Oban and Falkirk.—The Caledonian Electric Supply have notified that they will apply for provisional orders for these two towns.

Telephone Improvements in Glasgow.—The National Telephone Company have made several important alterations to the Glasgow exchange.

Rothsay.—This is another town included in the list of notices of the Caledonian Electric Lighting Company of intention to apply for powers.

Outing for Electric Light Employés.—The employés of the Bath Electric Light Company had, last Saturday week, an enjoyable outing.

Electric Lighting of Weston-super-Mare.—The Commissioners are enquiring about borrowing money for electric light purposes.

Electric Lighting of Tuam.—Notice has been given to the council by a local company of intention to apply for a provisional order.

The Lighting Plant at Leeds Town Hall.—It is said that the buying of new plant for the Town Hall lighting is contemplated.

Matrimony.—Mr. Nelson W. Perry, editor of the *Electrical World*, was married to Miss Marie Englina Bedell at the end of last month.

Bandon.—Bandon is in County Cork. Local feeling is strong enough to justify a local company applying for a provisional order.

Electric Lighting at Wakefield.—There is no electric lighting at Wakefield. The Town Council have apparently lost heart and are doing nothing.

Local Authorities and Tramways.—Copies of a Bill have been issued to facilitate the working of tramways by local authorities.

Dover.—The Town Council are considering the advisability of using dust destructors, but not for electric lighting purposes. Why not consider the two subjects together?

Woolwich Streets Depressed.—A local paper says that the streets of Woolwich are a good deal cut up just now. Cause, electric light mains.

Hammersmith Vestry.—The vestry have decided to consider the questions of the use of house refuse as fuel, and the electric light together.

Oil Engine Tests.—From tests recently carried out on a Trusty oil engine, it is computed that at full power the cost is one-third of a penny per I.H P. per hour.

Underground Cables in Brussels.—It is said that the laying of underground mains for the electric lighting is proceeding rapidly.

Church Lighting.—Huddersfield Parish Church has been closed for the purpose of fitting up 200 incandescent lamps. Messrs. Ernest Scott & Mountain are doing the work.

Waterloo and Mansion House Railway.—The bill which provides for the construction of this railway has been passed by the Unopposed Bill Committee.

Electric Light Pays at Sheffield.—The electric light company will pay a dividend of five per cent.

Provisional Orders Revoked.—Since 1883 the Board of Trade have revoked 103 provisional orders.

Electric Light Buoys.—Electric light buoys are being placed from Chicago harbour to the Exhibition.

Sale of Exhibits at Chicago.—Under certain restrictions exhibitors are now permitted to sell duplicates of their exhibits.

Visitors to the World's Fair.—They hope before the exhibition closes to record the attendance of 40 million people.

Edinburgh Electric Supply Corporation.—The company has been now formally wound up.

CITY NOTES.

Electric Construction Corporation.

A MEETING to confirm the resolutions of reconstruction passed at the meeting held a few days ago was held yesterday. The shareholders were unanimous. Mr. Beachcroft and Mr. Garcke have been appointed liquidators to wind up the old company.

National Telephone Company, Limited.

THE thirteenth ordinary general meeting of this company was held on Tuesday, at the Cannon Street Hotel, Mr. J. S. Forbes (the Chairman) presiding.

The SECRETARY (Mr. Albert Anns) read the notice calling the meeting.

The CHAIRMAN said the policy of the board during the last few years had been to bring in all the subsidiary outside companies. There was the Western Counties and South Wales Telephone Company, figuring at £277,607, and the telephone business of the Sheffield Telephone Exchange and Electric Light Company, which had cost £38,696. There were also some other minor companies, the whole coming to the not inconsiderable sum of £345,776. The peculiarity of the business was that every single new subscriber meant a special outlay, which had to be made in advance of the completion of the work, which work had to produce the income. The next item was that of "amounts expended within the year on construction of exchange, trunk and private lines and other capital charges, £305,799." These outlays had been provided on certain of the stocks—£141,000 in the shape of ordinary shares and third preference—in round numbers about £595,000, the influence of which came to be felt when they dealt with the net revenue account. They had not, however, done badly in the result, which showed a considerable addition to the business of the company. He had referred before to the necessity for finding a factor to enable them to measure the results. In the year they had increased from 47,878 to 59,031 wires, or an increase of 11,153 wires. He would qualify that by reminding them that into that period had been brought the *corpus* of the Western Telephone Company with their 4,000 wires. Deducting that, it showed that the normal progression of the business had been 7,153 wires. It was well to dispel illusions which existed in outside minds as to the cost of doing this, and if they actually divided the figures of £305,799 for construction of exchange, trunk, and private lines, they would find that the average was something like £42 per subscriber or per wire. Coming to the report, they would find that the income had reached £583,590, or an increase of £119,848 over the preceding year. They must remember, however, that the Sheffield Company and the Western Company were both included in these accounts, and that their income, which subsisted before they came in, was now incorporated in the accounts of this company. The united company had, however, contributed a very fair proportion to the increase. The next paragraph was an important one; it was that "the rentals carried forward this year for unexpired terms of running contracts amount to £285,020, as compared withh £234,370, or an increase of £50,649." He had explained this before, but he might repeat that the money was paid in advance, and that contracts were made from day to day or from month to month. In the year they were dealing with they had therefore received in cash, in the nature of trade payments, £50,649 more than in the corresponding year for services following in the coming year, but this was an increase of income already in their pockets. The working expenses were very large in proportion to the increase in money, being £75,392 out of the £119,000 of increase; but this arose from one or two causes. Like the income of the Western and the other companies brought in to swell the gross receipts, the working expenses of these new areas came in to swell the working expenses, and with this disadvantage in comparison, that these areas were more sparsely populated. The income per subscriber was relatively less, and the expenditure relatively more, than in a bigger undertaking, and to that extent they came in and, so to speak, diluted the averages. They were working at an enhanced percentage on the gross income, because they had added the gross income from those companies where the working expenses bore a higher proportion than in their own company. Again, the outlying areas were not developed quite to the extent of the parent districts, but all that would be for the pocket of the future. As they were developed there were certain charges, irrespective altogether of the individual subscribers, which were not affected by there being 1,000 or 2,000 more subscribers. Therefore, to that extent, they kept dropping the profits from such charges. They were not so large as in some companies, but quite considerable enough to be worth think-

ing about. The net result for the year, after deducting the Post Office royalties, amounting to £54,220, which was a pretty stiff tax to levy on a company like this, was a profit balance of £217,725. It would be seen that the Post Office stood always to win. The company were always being bullied because they did not reduce the tariffs, but a reduction of tariff did not mean that the expenses also were diminished. They were always being, by some people, attempted to be coerced, and by others, who were wiser, persuaded, into making reductions, but they had to remember that all the sacrifice came out of one pocket. Although the future of the company might be looked upon as being assured, the difference of a very small reduction might mean a very large effect on the dividends. If they looked at the figures before them, they would see they were not now so far in excess of the charges as to enable them to make any very great reduction. They were held up to odium because they were so enormously dear, and because they did not follow the times; and New York, Boston, St. Petersburg, Berlin, and other places, where the circumstances were entirely different, were mentioned. But the different circumstances had a very great effect upon the profit. The company was, as they would remember, fused, and its first year's work was in 1890. Then the average receipts throughout the area served was £14 11s. 4d.; in 1893 the average was reduced to £9 17s. 9d., and he would venture to say, with the greatest respect to all critics, that there was no comparison between that charge and the charge of any other great city in Europe, not even excluding Berlin. As to the effect of a reduction of expenditure, in 1890 the proportion of expenditure to earning was 49·49; in the past year it had been 62·69. The reduction came out of the shareholders' pockets, for the expenses were relatively a fixed figure, depending on the work that had to be done and not on the price paid for the telephone. The number of lines had been increased from 26,086 to 59,031; the dividend they had paid was 6 per cent., whereas they now paid 5 per cent. They could have paid 6 per cent. this year, but, for reasons which he would presently commend to their judgment, they had thought it wiser to pay only 5 per cent. In considering the company's position, it must be remembered the dangers they had passed through in dealing with the unknown, in making a new thing under such disadvantages that no other commercial company ever had, and on sufferance. They could not be compared with companies in other great cities, where, although the amount of the subscriptions did seem less, it was in some places, in fact, much larger, and notwithstanding the fact that they were free of things which affected the National Telephone Company most seriously. They had no way-leaves, for instance, and certainly not 10 per cent. payable to the State at the risk of somebody else. The average per assured tenancy during the past year had amounted to £15 0s. 7d., but that amount could not be compared with other cities that were thrown in their teeth. London was three times as big as Paris, for instance, and the whole area was included in the subscription, and the work was carried on under extreme disadvantages. Amongst those disadvantages was that of having to pay £1 4s. in London for way-leaves for every wire. Then those with whom they were sometimes compared did not pay a Post Office royalty; this company paid £1 6s. 9d. He maintained that London was the cheapest city in the world for telephones, and he was quite willing to accept the challenge of any expert or critic on the figures The average charge for their wire throughout the whole country, excluding London, was £8 16s. 10d.; including London it was £9 16s. 10d. The net result for the year, after deducting the royalties, was £217,725, which was a net increase of £30,475. What were they to do with that balance? Of course, the preference shares were to be paid in full—that was 6 per cent. upon the two small issues of £150,000 preference shares; then came 250,000 third preference shares of £5 each, of which they had issued £594,880, and then came the ordinary shares, and upon that major quantity of ordinary shares they proposed to pay 5 per cent., instead of 6 per cent., for the reasons indicated in the report. Five per cent. was not so bad in these times, and as time went on and Consols diminished in value, it would be brilliant if they could pay a permanent 5 per cent., with a strong reserve. The chairman then read two letters which had been addressed to the board. The first was from one of the largest shareholders, who said he was glad to see that the directors had decided to add to the reserve rather than to dividends, and mentioned that he had added to his holding since the reduced dividend was announced. The other writer took the opposite line, and said only dire necessity, of which he could see no indication in the report, could justify the reduction. The directors, the chairman continued, certainly did not decide on the reduction with a light heart, but because they considered it their duty to the shareholders, with their full knowledge of all the circumstances, past, present, and likely to arise, to recommend it. The chairman next referred to paragraph 8 of the report, relating to the partnership the company had acquired in the New Telephone Company, and said the board had considered it prudent to come to the arrangement set forth. During the year negotiations of a complicated nature had been carried on with the Post Office in relation to the acquisition by the Government of the company's trunk lines, resulting in an agreement being arrived at. The Government had adopted a policy. Of course they had a right to take the telephone over at any time they liked by agreement, but they had not taken it over; they had elected that the company should go on, but they were uncomfortable because they had not got their finger in the company's pie, and they decreed that the most difficult and costly part of the business should be committed to the company, but that they should keep the arterial process in their own hands. They were going to have two departments to do the work of one. It amounted, to a certain extent, to disruption, which seemed to be the policy of some governments. The board would have to submit their judgment to that of the Post Office, and they go to the Treasury. However, they had had to make the best of things, which their judgment could not approve. He concluded by moving the adoption of the report and accounts, and the declaration of the dividends as recommended.

Lord BALFOUR OF BURLEIGH seconded the motion, which was agreed to.

The retiring directors and auditors were re-appointed, and a vote of thanks to the chairman closed the proceedings.

First Hungarian Joint Stock Electrical Company.

ACCORDING to intelligence of the date of June 5th, the company in question, set on foot by the firm Ganz & Co., and the Vienna International Electric Company, held its constituting general meeting this afternoon at the offices of Ganz & Co. All the shares were represented by the subscribers. The share capital of the company was for the present fixed at 1,500,000 florins or three million crowns, divided into 15,000 fully paid up shares of 100 florins each. It was proved at the meeting that this capital has been paid up in full. The statutory scope of the new company comprises the entire field of electro-technics, so that it will undertake not merely the supply of electric light for public and private consumers, but will furnish electric power for industrial motors and will also turn its attention to the electric working of railways and tramlines. As it was stated at the general meeting the company will undertake, on favourable conditions a series of installations in the territory of the Hungarian crown, partly already in action and partly approaching completion (at Fiume, Eilau, Fünfkirchon, &c.), and in particular as the legal successor of the firm Ganz & Co., it will carry out the concession which the municipality of Buda-Pesth had granted to Ganz & Co. for the erection of a central station.

As regards providing the funds required for the Buda-Pesth central station, the share capital immediately after the grant of the ministerial concession will be increased to six million crowns.

The board includes privi-councillor Dr. Alex von Mattekorits, vice-chairman of the International Electrical Company of Vienna; imperial councillor Leopold Altmann, director of the Union Bank of Vienna, &c. There is also a Council of Inspection, including Geroe, Hüttl, Von Jokai, and Konyi.

The financing of the shares is undertaken by a syndicate, at the head of which stand the Union Bank, and the Hungarian Banc Escompte. In the allotment of shares the shareholders of Ganz & Co., and of the Vienna International Electrical Company will have the preference.

Sheffield Electric Light and Power Company, Limited.

THE second ordinary general meeting of shareholders of the above company was held this week at the company's offices, in Commercial Street. A dividend of 5 per cent. per annum was declared, free of income tax, and the retiring directors were re-elected. The chairman, Mr. George Franklin, explained that in view of the undoubted growing demand for electric light, it had been found necessary to rebuild and enlarge the central station in order to make room for new machinery. The new steam and electrical plant would be of the most modern description, and would probably be at work during the present autumn. The station would have an ultimate generating capacity of 80,000 lamps. Twelve and a half miles of underground conduits had been laid in the streets for the reception of the distributing cables. The prospects of the company were most encouraging, and a new issue of 4,000 ordinary shares would probably be made in the near future.

The Direct United States Cable Company, Limited.—It has been resolved to recommend a final dividend of 3s. 6d. per share, free of income tax, such dividend to be payable on and after the 29th inst., making, with the interim dividends already paid, 3½ per cent. for the year ending June 30th last, and, after placing £3,000 to reserve fund account, carrying forward a balance of £819 2s. 4d. The transfer books of this company will be closed from the 14th to the 28th July (both days inclusive).

Anglo-American Telegraph Company, Limited.—The directors have resolved to declare an interim dividend for the quarter ending June 30th, 1893, of 12s. 6d. per cent. on the ordinary stock and 25s. per cent. on the preferred stock, less income tax, payable on August 1st to the stockholders registered on the books of the company on July 10th, 1893.

Kensington and Knightsbridge Electric Lighting Company, Limited.—The interim dividend warrants for the past half-year on the first preference shares at the rate of 6 per cent. per annum have been posted, also an interim dividend on the ordinary shares at the rate of 4 per cent. per annum will be payable on the 31st inst.

City and South London Railway Company.—The directors recommend a dividend of 5 per cent. on the preference shares, and of ¾ per cent. per annum on the ordinary stock.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending July 16th, 1893, amounted to £774; week ending July 17th, 1892, £766; increase £8; total receipts for half-year, 1893, £1,843; corresponding period, 1892, £1,499; increase £344.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 14th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,846.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation, July 12th.	Closing Quotation July 19th.	Business done during week ended July 19th, 1893. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	100½	100¼
1,134,640*l*	Anglo-American Telegraph, Limited	Stock	51 — 52	50½— 51½	51	...
2,932,680*l*	Do. do. 6 p. c. Preferred	Stock	94 — 95	94 — 95	95	94
2,876,140*l*	Do. do. Deferred	Stock	10 — 10½	9½ — 10	10¼	9⅞
130,000	Brazilian Submarine Telegraph, Limited	10	11¾— 12⅛	11⅞ — 12¼	12 1/16	11⅞
36,400*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	106 —110	106 —110	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3½	2⅞ — 3½	3 1/16	...
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2⅛ — 2⅜	2 1/16	2⅛
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	107 —109	107 —109	...	...
20,510	Charing Cross & Strand Electricity Supply Nos. 1 to 6, 215 to 718, and 10,001 to 30,000	5	5 — 5½	5 — 5½	...	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	2 — 3	2 — 3	...	...
630,000*l*	City and South London Railway	Stock	35 — 37	35 — 37	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11¼— 11⅜	10⅞— 11¼	11⅛	11
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12⅜— 13¼	12¼— 13 xd	12 1/16	12⅛
$7,716,000	Commercial Cable, Capital Stock	$100	138 —142	138 —142	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	⅛ — ¼	⅛ — ¼	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½ — 5⅝	5 — 5½	5⅛	5⅛
16,000	Cuba Telegraph, Limited	10	11½ — 12¼	11¼ — 12¼	12	...
6,000	Do. do. 10 p. c. Preference	10	18½ — 19½	18½ — 19½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ — 3½	2½ — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅞ — 12⅛	11⅞ — 12⅛	...	...
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15¼ — 15½	15 — 15¼	15 7/16	15
70,000	Do. 6 p. c. Preference	10	16½ — 17	16½ — 17	16 9/16	...
105,900*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,294,100*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	112 —115	112 —115	...	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15⅞ — 16	15½— 15⅞xd	15 13/16	15⅝
70,600*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	...	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	113 —116	113 —116	113¼	...
108,700*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	101 —104	...	...
146,800*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	101 —104	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	102 —105	102 —105	104¼	...
49,900	Electric Construction, Limited, Nos. 101 to 45,100	10	1⅞ - 2¼	1⅞ - 2¼	2 1/16	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	⅛ — ¼	⅛ — ¼	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	⅜ — ⅝	¼ — ⅜	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	⅛ — ⅜	⅛ — ⅜	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	1 — 2	1 — 2	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜— 10	9⅜— 10	10	9⅞
160,042	Do. do. 6 p. c. Preference	10	15⅝ — 15⅞	15⅝ — 15⅞	15 13/16	15¾
150,000	Great Northern Tel. Company of Copenhagen	10	19½ — 20	19½ — 20	...	...
200,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5½	4½ — 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6 — 7	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	23 — 24	22 — 23 xd	22⅞	...
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 42	39 — 42	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000 ...	10	2½ — 3½	2½ — 3½	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4 5/16 — 4 7/16	4 5/16 — 4 7/16	...	...
10,000	Do. do. fully paid	5	6⅝— 6¾	6⅝— 6⅝	...	...
37,548	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	107 —110	107 —110	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6½ — 7	6 — 6½	6⅝	...
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 —105	102 —105	...	...
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	1½— 2½	1½— 2½	...	...
28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	3 — 4	3 — 4	...	...
458,867	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜ - 4⅞	4⅜— 5	4 1/16	4 1/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	14½ — 15½	14½ — 15½	16⅛	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	14½ — 14⅝	14½ — 14⅝	14 9/16	...
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5⅜— 5⅝	5⅜— 5⅜	...	...
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	110 —115	110 —115	113¾	112¾
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,451	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	⅛ — ¼	⅛ — ¼	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	100 —103	100 —103	...	...
11,802	Reuter's Limited	8	5 — 6	5 — 6	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7¼— 7⅜	7 — 7⅛	7 5/16	6⅞
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7⅞— 8⅛	8 — 8⅛	8 1/16	8
3,381	Submarine Cables Trust	Cert.	120 —125	119 —124	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	1⅞— 2¼	1⅞— 2¼	...	...
37,350	Telegraph Construction and Maintenance, Limited	12	34 — 36	33 — 35	...	...
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	2½— 3	2 — 2½	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	99 —102	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½ — 6½	5½ — 6½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	...	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	99 —103	97 —101	99¾	...
64,242	Western and Brazilian Telegraph, Limited	15	7¼— 7⅜	7¼ - 7⅜	7⅜	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	5¾ - 6¼	6⅜	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1½ — 2	1½ - 2	1⅝	1 3/16
178,200*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 —109	106 1.9	108¼	...
222,700*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 —109	106 -109	...	...
88,321	West India and Panama Telegraph, Limited	10	1½— 1⅝	1½ - 1⅝	1½	1 3/16
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10½— 11	10½ 11	10½	...
4,669	Do do do. 6 p. c. 2nd Preference ...	10	9½—10½	9½ - 10½	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	105 —108	105 —108	...	...
8,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
169,000*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —105	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5½— 3¾	5½— 5¾	...	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

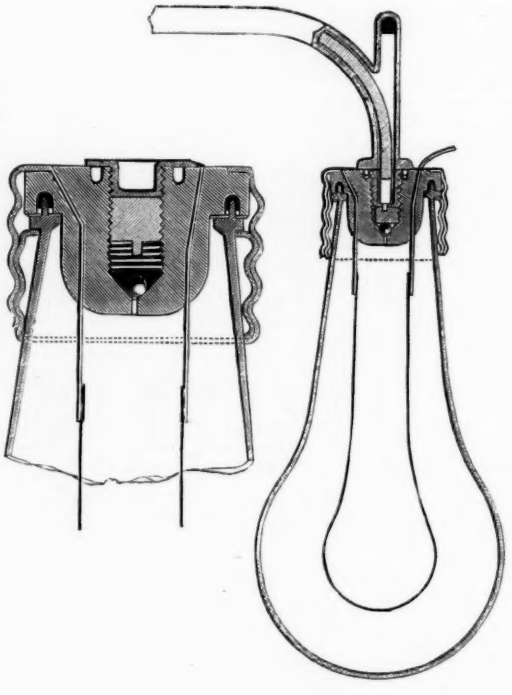
LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid), 1⅜—2⅛.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5—5⅛.—House to House Company (£5 paid) 1⅛—2⅛.—Do. 7 per cent. Preference of £5, 5—5⅛.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅞—6⅛, 1st Preference Cumulative 6 per cent., £5 (fully paid, 6—6⅛.—Manchester Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating 6 per cent. £10 Debentures, 101 c

[bank rate of discount, 2½ per cent (June 15th, 1893).

ANOTHER "DETACHABLE" INCANDESCENT LAMP.

MODIFICATIONS of "detachable" incandescent lamps are becoming quite the fashion with American inventors. Mr. A. E. Guy, of Washington, has lately devised a form of lamp on this principle, some features of which possess distinct ingenuity. But a display of ingenuity is by no means always attended with commercial success, and we should be a little surprised to hear that this particular form should receive the success we presume the inventor anticipates. The following is a description of the lamp given by an American contemporary :—

"A new incandescent lamp, which we illustrate, involving several interesting features, has recently been patented by Mr. A. E. Guy, of Washington, D.C.



"The socket is provided with a groove, in which a little mercury is placed. The globe, which need not be blown, and may be cast, has at its base a thin projecting ring of glass, inside and outside of which thin rings of asbestos are slipped, thereby forming a packing for the mercury and its vapours. Then the globe is connected with the socket, and both held together by means of brass shells, the inside one being split open so as to permit the placing of such around the neck of the globe. A plug of any convenient material is screwed in the central hole of the socket. The plug pushes up a little paper ball and stops before closing the top aperture. The socket is then made fast to a tube connecting with a vacuum pump and containing a flexible cable terminated as a screw-driver. The air is then exhausted from the lamp, and if such is to be the case, replaced by a gas, as in some lamps now on the market.

"When the lamp is ready to be closed, the cable is put into motion and the plug is pushed up, the paper ball closing the top aperture. The vacuum tube is then turned downward and a little quantity of mercury contained in a recess falls into the socket, passes through a groove in the plug, and surrounds the paper ball. The lamp is withdrawn, the central hole half filled with plaster of paris, and a brass cap secured in place. The wire connections are established as shown in the enlarged sectional view of the socket of a completed lamp.

"The socket can be cast of glass or porcelain and made of any shape, to suit any of the lamps now in use. The brass sleeves are stamped. If found more convenient for certain lamps the central hole can be dispensed with, the globe being then provided with screw threads inside and outside, as such threads are easily molded.

"The renewal of the carbon filament is done by a very simple operation necessitating no skilled labour, and the lamp is thus given, at the cost of a few cents, a life which, barring accidents, may be considered as indefinite.

"The globe of the lamp, as stated before, need not be blown ; it comes out of the mold complete and ready for use. The blowpipe is no more required for making or sealing the lamp, and the delicate operations by which the 'all glass' lamp is now made are entirely avoided.

"The simplicity and the small cost at which it is claimed the lamp can be made are qualities most desirable in any article of manufacture ; but to these qualities is added a still more important one in this lamp, viz., the easy renewal of the carbon filament without any alteration whatever to the different parts of the lamp."

To render such a device serviceable, exceeding delicate and nice workmanship would be required, to prevent leakage. The description does not make it very clear how the air is prevented from entering into the bulb through the mercury groove joint when exhausting the bulb. It is difficult to see how a porous washer of asbestos should be sufficient to keep the mercury in the groove against the atmospheric pressure. It is also not very apparent how the cable screw drive is rotated in order to seal the lamp, though to accomplish this would not be a difficulty of the same magnitude as the preceding. Assuming the technical difficulties to be successfully overcome, the advantages of the lamp would be practically on the same footing as the new Westinghouse lamp, though more complicated to make in the first instance.

From the two concluding paragraphs of the extract it would seem that Mr. Guy regards the blowpipe and glass blowing operations as anything but desirable agents in the manufacture of incandescent lamps. These means have, however, proved exceedingly efficient and economical in the past, and the day is likely to be very remote before they become doomed to disuse.

NOTE ON GEOMETRICAL PROOF OF THE THREE-AMMETER METHOD OF MEASURING POWER.

BY FREDERICK BEDELL AND ALBERT C. CREHORE.*

THE methods, now well-known, for measuring power by three voltmeters or three ammeters, first shown by Prof. Ayrton and Dr. Sumpner, † are applicable to the measurement of power of any circuit irrespective of the nature of the impressed electromotive force, and the general proof of the methods is given in the paper referred to. In the case of an harmonic electromotive force the methods are capable of simple geometrical proof. The writers have shown this ‡ for the voltmeter method, and in this note will be given the corresponding proof for the three-ammeter method.

Let R_2 L_2, fig. 1, be an inductive circuit whose power is to

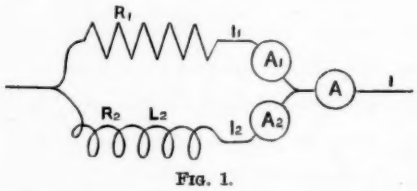


FIG. 1.

be measured, and R_1 a non-inductive resistance in parallel with it. If the maximum values of the main and branch currents be denoted by I, I_1 and I_2, respectively, they may be represented as shown in fig. 2. The current, I_1, is in phase with the impressed electromotive force, E ; the main current, I, lags behind it by an angle, θ ; and the current, I_2,

* *Physical Review.*

† "The Measurement of Power given by any Electric Current to any Circuit," *Proc. Roy. Soc*, xlix., p. 424.

‡ "Alternating Currents," p. 230.

lags behind it by an angle, θ_2. The tangent of θ_2 is $\frac{L_2\,\omega}{R_2}$; and the tangent of θ is $\frac{L'\,\omega}{R'}$, where R′ and L′ denote

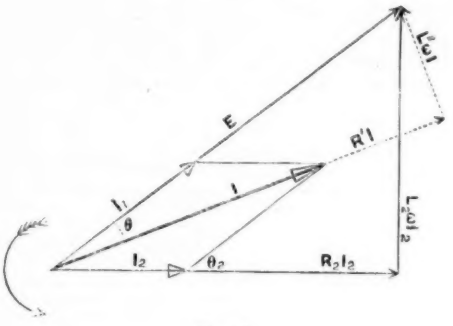


FIG. 2.

the equivalent resistance and self induction of the parallel circuit,* and ω is $2\,\pi$ times the frequency.

The power expended in the inductive circuit is $W_2 = \frac{1}{2}\,E\,I\cos\theta_2$. From the geometry of the figure

$$\cos\theta_2 = \frac{I^2 - I_1^2 - I_2^2}{2\,I_1\,I_2};$$

whence

$$W_2 = \frac{E}{4\,I_1}\,(I^2 - I_1^2 - I_2^2),$$

where E, I, I_1, and I_2 represent maximum values. Writing virtual or square root of mean square values as obtained from ordinary measuring instruments, the expression for the power becomes:

$$W_2 = \frac{\overline{E}}{2\,\overline{I_1}}\,(\overline{I^2} - \overline{I_1^2} - \overline{I_2^2}).$$

The power in the non-inductive branch is

$$W_1 = \overline{E}\,\overline{I_1};$$

and the total power in the two branches is

$$W = \frac{\overline{E}}{2\,\overline{I_1}}\,(I^2 + I_1^2 - I_2^2).$$

The method is thus geometrically established for harmonic currents, which may be represented by lines in a vector diagram. For an alternating current, not harmonic, the proof does not hold unless we assume the current to be equivalent to an harmonic current, and the question then arises as to what will be the equivalent harmonic current. The equivalent harmonic current must be such that its square root of the mean square value, and the expenditure of energy in the circuit, are the same as in the case of the given current which was not harmonic.

ON LIGHT AND OTHER HIGH FREQUENCY PHENOMENA.†

BY NIKOLA TESLA.

(*Continued from page* 53.)

In connection with resonance effects and the problem of transmission of energy over a single conductor which was previously considered, I would say a few words on a subject which constantly fills my thoughts and which concerns the welfare of all. I mean the transmission of intelligible signals or perhaps even power to any distance without the use of wires. I am becoming daily more convinced of the practicability of the scheme; and though I know full well that the great majority of scientific men will not believe that such results can be practically and immediately realised, yet I think that all consider the developments in recent years by a number of workers to have been such as to encourage thought and experiment in this direction. My conviction has grown so strong that I no longer look upon this plan of energy or intelligence transmission as a mere theoretical possibility, but as a serious problem in electrical engineering, which must be carried out some day. The idea of transmitting intelligence without wires is the natural outcome of the most recent results of electrical investigations. Some enthusiasts have expressed their belief that telephony to any distance by induction through the air is possible. I cannot stretch my imagination so far, but I do firmly believe that it is practicable to disturb by means of powerful machines the electrostatic condition of the earth and thus transmit intelligible signals and perhaps power. In fact, what is there against the carrying out of such a scheme? We now know that electric vibration may be transmitted through a single conductor. Why then not try to avail ourselves of the earth for this purpose? We need not be frightened by the idea of distance. To the weary wanderer counting the mile-posts the earth may appear very large, but to that happiest of all men, the astronomer, who gazes at the heavens and by their standard judges the magnitude of our globe, it appears very small. And so I think it must seem to the electrician, for when he considers the speed with which an electric disturbance is propagated through the earth all his ideas of distance must completely vanish.

A point of great importance would be first to know what is the capacity of the earth? and what charge does it contain if electrified? Though we have no positive evidence of a charged body existing in space without other oppositely electrified bodies being near, there is a fair probability that the earth is such a body, for by whatever process it was separated from other bodies—and this is the accepted view of its origin—it must have retained a charge, as occurs in all processes of mechanical separation. If it be a charged body insulated in space its capacity should be extremely small, less than one-thousandth of a farad. But the upper strata of the air are conducting, and so, perhaps, is the medium in the free space beyond the atmosphere, and these may contain an opposite charge. Then the capacity might be incomparably greater. In any case it is of the greatest importance to get an idea of what quantity of electricity the earth contains. It is difficult to say whether we shall ever acquire this necessary knowledge, but there is hope that we may, and that is, by means of electrical resonance. If ever we can ascertain at what period the earth's charge, when disturbed, oscillates with respect to an oppositely-electrified system or known circuit, we shall know a fact possibly of the greatest importance to the welfare of the human race. I propose to seek for the period by means of an electrical oscillator, or a source of alternating electric currents. One of the terminals of the source would be connected to earth, as, for instance, to the city water mains, the other to an insulated body of large surface. It is possible that the outer conducting air strata or free space contains an opposite charge, and that, together with the earth, they form a condenser of very large capacity. In such case the period of vibration may be very low, and an alternating dynamo machine might serve for the purpose of the experiment. I would then transform the current to a potential as high as it would be found possible, and connect the ends of the high tension secondary to the ground and to the insulated body. By varying the frequency of the currents and carefully observing the potential of the insulated body, and watching for the disturbance at various neighbouring points of the earth's surface resonance might be detected. Should, as the majority of scientific men in all probability believe, the period be extremely small, then a dynamo machine would not do, and a proper electrical oscillator would have to be produced, and perhaps it might not be possible to obtain such rapid vibrations. But whether this be possible or not, and whether the earth contains a charge or not, and whatever may be its period of vibration, it certainly is possible—for of this we have daily evidence—to produce some electrical disturbance sufficiently powerful to be perceptible by suitable instruments at any point of the earth's surface.

Assume that a source of alternating currents, S, be connected, as in fig. 21, with one of its terminals to earth (conveniently to the water mains) and with the other to a body of large surface, P. When the electric oscillation is set up there will be a movement of electricity in and out of P, and alternating currents will pass through the earth, converging to, or diverging from, the point, C, where the ground connection is made. In this manner neighbouring points on the earth's surface within a certain radius will be disturbed. But the disturbance will diminish with the distance, and the distance at which the effect will still be perceptible will depend on the quantity of electricity set in motion. Since the body, P, is insulated, in order to displace a considerable quantity the potential of the source must be excessive, since there would be limitations as to the surface of P. The conditions might be adjusted so that the generator or source, S, will set up the same electrical movement as though its circuit were closed. Thus it is certainly practicable to impress an electric vibration at least of a certain low period upon the earth, by means of proper machinery. At what distance such a vibration might be made perceptible can only be conjectured. I have on another occasion considered the question how the earth might behave to electric disturbances. There is no doubt that, since in such an experiment the electrical density at the surface could be but extremely small, considering the size of the earth, the air would not act as a very disturbing factor, and there would be not much energy lost through the action of the air, which would be the case if the density were great. Theoretically, then, it could not require a great amount of energy to produce a disturbance perceptible at great distance, or even all over the surface of the globe. Now, it is quite certain that at any point within a certain radius of the source, S, a properly adjusted self-induction and capacity device can be set in action by resonance. But not only can this be done, but another source, S_1, fig. 21, similar to S, or any number of such sources can be set to work in synchronism with the latter, and the vibration thus intensified and spread over a large area, or a flow of electricity produced to or from the source, S_1, if the same be of opposite phase to the source, S. I think that beyond

* "Equivalent Resistance, Self Induction and Capacity of Parallel Circuits with Harmonic Impressed Electromotive Force." Bedell and Crehore, *Phil. Mag.* September, 1892.

† A lecture delivered before the Franklin Institute, at Philadelphia, February 24th, 1893, and before the National Electric Light Association, at St. Louis, Mo., March 1st, 1893.

doubt it is possible to operate electrical devices in a city through the ground or pipe system by resonance from an electrical oscillator located at a central point. But the practical solution of this problem would be of incomparably smaller benefit to man than the realisation of the scheme of transmitting intelligence, or perhaps power, to any distance through the earth or environing medium. If this is at all possible, distance does not mean anything. Proper apparatus must first be produced by means of which the problem can be attacked, and I have devoted much thought to this subject. I am firmly convinced that it can be done, and hope that we shall live to see it done.

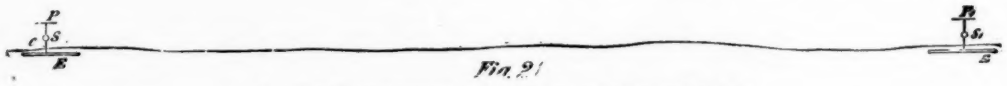


Fig. 21.

ENERGY TRANSMISSION TO ANY DISTANCE WITHOUT WIRES.

ON THE LIGHT PHENOMENA PRODUCED BY HIGH-FREQUENCY CURRENTS OF HIGH POTENTIAL AND GENERAL REMARKS RELATING TO THE SUBJECT.

Returning now to the light effects which it has been the chief object to investigate, it is thought proper to divide these effects into four classes: 1. Incandescence of a solid. 2. Phosphorescence. 3. Incandescence or phosphorescence of a rarefied gas, and 4. Luminosity produced in a gas at ordinary pressure. The first question is, How are these luminous effects produced? In order to answer this question as satisfactorily as I am able to do in the light of accepted views, and with the experience acquired, and to add some interest to this demonstration, I shall dwell here upon a feature which I consider of great importance, inasmuch as it promises, besides, to throw a better light upon the nature of most of the phenomena produced by high-frequency electric currents. I have on other occasions pointed out the great importance of the presence of the rarefied gas, or atomic medium in general, around the conductor through which alternate currents of high frequency are passed, as regards the heating of the conductor by the currents. My experiments described some time ago have shown that the higher the frequency and potential difference of the currents, the more important becomes the rarefied gas in which the conductor is immersed, as a factor of the heating. The potential difference, however, is, as I then pointed out, a more important element than the frequency. When both of these are sufficiently high, the heating may be almost entirely due to the presence of the rarefied gas. The experiments to follow will show the importance of the rarefied gas, or generally of gas at ordinary or other pressure as regards the incandescence or other luminous effects produced by currents of this kind.

I take two ordinary 50 volt 16 C.P. lamps which are in every respect alike, with the exception, that one has been opened at the top and the air has filled the bulb, while the other is at the ordinary degree of exhaustion of commercial lamps. When I attach the lamp which is exhausted to the terminal of the secondary of the coil, which I have already used as in experiments illustrated in fig. 15*a* for instance, and turn on the current, the filament as you have before seen comes to high incandescence. When I attach the second lamp, which is filled with air, instead of the former, the filament still glows, but much less brightly. This experiment illustrates only in part the truth of the statements before made. The importance of the filament's being immersed in rarefied gas is plainly noticeable but not to such a degree as might be desirable. The reason is that the secondary of this coil is wound for low tension, having only 150 turns, and the potential difference at the terminals of the lamp is therefore small. Were I to take another coil with many more turns in the secondary, the effect would be increased, since it depends partially on the potential difference, as before remarked. But since the effect likewise depends on the frequency, it may be properly stated that it depends on the time rate of the variation of the potential difference. The greater this variation the more important becomes the gas as an element of heating. I can produce a much greater rate of variation in another way, which, besides has the advantage of doing away with the objections, which might be made in the experiment just shown, even if both the lamps were connected in series or multiple arc to the coil, namely, that in consequence of the reactions existing between the primary and secondary coil the conclusions are rendered uncertain. This result I secure by charging from an ordinary transformer, which is fed from the alternating current supply station, a battery of condensers, and discharging the latter directly through a circuit of small self-induction, as before illustrated in fig. 19*a*, 19*b*, 19*c*.

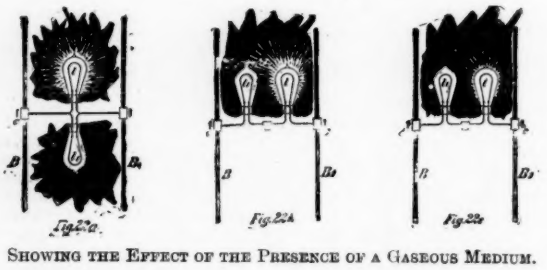


Fig. 22*a*. Fig. 22*b*. Fig. 22*c*.

SHOWING THE EFFECT OF THE PRESENCE OF A GASEOUS MEDIUM.

In figs. 22*a*, 22*b*, and 22*c*, the heavy copper bars, BB$_1$, are connected to the opposite coatings of a battery of condensers, or generally in such way, that the high frequency or sudden discharges are made to traverse them. I connect first an ordinary 50-volt incandescent lamp to the bars by means of the clamps, *cc*. The discharges being passed through the lamp, the filament is rendered incandescent, though the current through it is very small, and would not be nearly sufficient to produce a visible effect under the conditions of ordinary use of the lamp. Instead of this I now attach to the bars another lamp exactly like the first, but with the seal broken off, the bulb being therefore filled with air at ordinary pressure. When the discharges are directed through the filament, as before, it does not become incandescent. But the result might still be attributed to one of the many possible reactions. I therefore connect both the lamps in multiple arc, as illustrated in fig. 22*a*. Passing the discharges through both the lamps, again the filament in the exhausted lamp, *l*, glows very brightly, while that in the non-exhausted lamp, l_1, remains dark, as previously. But it should not be thought that the latter lamp is taking only a small fraction of the energy supplied to both the lamps; on the contrary, it may consume a considerable portion of the energy and it may become even hotter than the one which burns brightly. In this experiment the potential difference at the terminals of the lamps varies in sign theoretically three to four million times a second. The ends of the filaments are correspondingly electrified, and the gas in the bulbs is violently agitated, and a large portion of the supplied energy is thus converted into heat. In the non-exhausted bulb there being a few million times more gas molecules than in the exhausted one, the bombardment, which is most violent at the ends of the filament, in the neck of the bulb, consumes a large portion of the energy without producing any visible effect. The reason is that, there being many molecules, the bombardment is quantitatively considerable, but the individual impacts are not very violent, as the speeds of the molecules are comparatively small, owing to the small free path. In the exhausted bulb, on the contrary, the speeds are very great, and the individual impacts are violent, and therefore better adapted to produce a visible effect. Besides, the convection of heat is greater in the former bulb. In both the bulbs the current traversing the filaments is very small, incomparably smaller than that which they require on an ordinary low-frequency circuit. The potential difference, however, at the ends of the filaments is very great, and might be possibly 20,000 volts or more, if the filaments were straight and their ends far apart. In the ordinary lamp a spark generally occurs between the ends of the filament or between the platinum wires outside, before such a difference of potential can be reached.

It might be objected in the experiment before shown, that the lamps, being in multiple arc, the exhausted lamp might take a much larger current, and that the effect observed might not be exactly attributable to the action of the gas in the bulbs. Such objections will lose much weight if I connect the lamps in series, with the same result. When this is done, and the discharges are directed through the filaments, it is again noted that the filament in the non-exhausted bulb, l_1, remains dark, while that in the exhausted one (l) glows even more intensely than under its normal conditions of working, fig. 22*b*. According to general ideas, the current through the filaments should now be the same, were it not modified by the presence of the gas around the filaments.

At this juncture I may point out another interesting feature, which illustrates the effect of the rate of change of potential of the currents. I will leave the two lamps connected in series to the bars, B, B$_1$, as in the previous experiment, fig. 22*b*, but will presently reduce considerably the frequency of the currents, which was excessive in the experiment just before shown. This I may do by inserting a self-induction coil in the path of the discharges, or by augmenting the capacity of the condensers. When I now pass these low-frequency discharges through the lamps, the exhausted lamp, *l*, again is as bright as before, but it is noted also that the non-exhausted lamp, l_1, glows, though not quite as intensely as the other. Reducing the current through the lamps, I may bring the filament in the latter lamp to redness, and though the filament in the exhausted lamp, *l*, is bright, fig. 22*c*, the degree of its incandescence is much smaller than in fig. 22*b*, when the currents were of a much higher frequency.

In these experiments the gas acts in two opposite ways in determining the degree of the incandescence of the filaments, that is, by convection and bombardment. The higher the frequency and potential of the currents, the more important becomes the bombardment. The convection, on the contrary, should be the smaller, the higher the frequency. When the currents are steady, there is practically no bombardment, and convection may therefore, with such currents, also considerably modify the degree of incandescence and produce results similar to those just before shown. Thus, if two lamps exactly alike, one exhausted and one not exhausted, are connected in multiple arc or series to a direct current machine, the filament in the non-exhausted lamp will require a considerably greater current to be rendered incandescent. This result is entirely due to convection, and the effect is the more prominent the thinner the filament. Prof. Ayrton and Mr. Kilgour, some time ago published quantitative results concerning the thermal emissivity by radiation and convection in which the effect of thin wires was clearly shown. This effect may be strikingly illustrated by preparing a number of small short glass tubes, each containing through its axis the thinnest obtainable platinum wire. If these tubes be highly exhausted, a number of them

may be connected in multiple arc to a direct-current machine, and all of the wires may be kept at incandescence with a smaller current than that required to render incandescent a single one of the wires if the tube be not exhausted. Could the tubes be so highly exhausted that convection would be nil, then the relative amounts of heat given off by convection and radiation could be determined without the difficulties attending thermal quantitative measurements. If a source of electric impulses of high frequency and very high potential is employed, a still greater number of the tubes may be taken, and the wires rendered incandescent by a current not capable of warming perceptibly a wire of the same size immersed in air at ordinary pressure, and conveying the energy to all of them.

I may here describe a result which is still more interesting, and to which I have been led by the observation of these phenomena. I noted that small differences in the density of the air produced a considerable difference in the degree of incandescence of the wires, and I thought that, since in a tube, through which a luminous discharge is passed, the gas is generally not of uniform density, a very thin wire contained in the tube might be rendered incandescent at certain places of smaller density of the gas, while it would remain dark at the places of greater density, where the convection would be greater, and the bombardment less intense. Accordingly a tube, *t*, was prepared, as illustrated in fig. 23, which contained through the middle

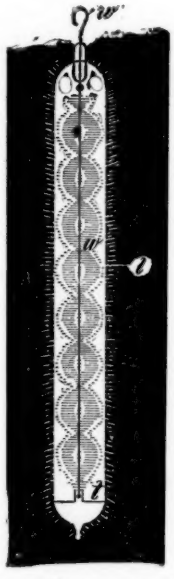


FIG. 23.—CURIOUS INCANDESCENCE OF A WIRE.

a very fine platinum wire, *w*. The tube was exhausted to a moderate degree, and it was found that when it was attached to the terminal of a high-frequency coil, the platinum wire, *w*, would, indeed, become incandescent in patches, as illustrated in fig. 23. Later, a number of these tubes, with one or more wires, were prepared, each showing this result. The effect was best noted when the striated discharge occurred in the tube, but was also produced when the striæ were not visible, showing that, even then, the gas in the tube was not of uniform density. The position of the striæ was generally such, that the rarefactions corresponded to the places of incandescence or greater brightness on the wire, *w*. But in a few instances it was noted that the bright spots on the wire were covered by the dense parts of the striated discharge, as indicated by *l* in fig. 23, though the effect was barely perceptible. This was explained in a plausible way by assuming that the convection was not widely different in the dense and rarefied places, and that the bombardment was greater on the dense places of the striated discharge. It is, in fact, often observed in bulbs, that under certain conditions a thin wire is brought to higher incandescence when the air is not too highly rarefied. This is the case when the potential of the coil is not high enough for the vacuum, but the result may be attributed to many different causes. In all cases this curious phenomenon of incandescence disappears when the tube, or rather the wire, acquires throughout a uniform temperature.

Disregarding now the modifying effect of convection there are then two distinct causes which determine the incandescence of a wire or filament with varying currents, that is, conduction current and bombardment. With steady currents we have to deal only with the former of these two causes, and the heating effect is a minimum, since the resistance is least to steady flow. When the current is a varying one, the resistance is greater, and hence the heating effect is increased. Thus if the rate of change of the current is very great, the resistance may increase to such an extent that the filament is brought to incandescence with inappreciable currents, and we are able to take a short and thick block of carbon or other material and bring it to bright incandescence with a current incomparably smaller than that required to bring to the same degree of incandescence an ordinary thin lamp filament with a steady or low frequency current. This result is important, and illustrates how rapidly our views on these subjects are changing, and how quickly our field of knowledge is extending. In the art of incandescent lighting, to view this result in one aspect only, it has been commonly considered as an essential requirement for practical success, that the lamp filament should be thin and of high resistance. But now we know that the resistance to the steady flow of the filament does not mean anything; the filament might as well be short and thick; for if it be immersed in rarefied gas it will become incandescent by the passage of a small current. It all depends on the frequency and potential of the currents. We may conclude from this, that it would be of advantage, so far as the lamp is considered, to employ high frequencies for lighting, as they allow the use of short and thick filaments and smaller currents.

(To be continued.)

NEW PATENTS—1893.

13,024. "Improvements in instruments for measuring and indicating electrical energy, and for other measurements." G. CHEFFEY-JAMES. Dated July 4th.

13,064. "Improvements in devices for prevention of retardation in electric cables." S. P. THOMPSON. Dated July 4th.

13,066. "Improvements in or relating to the manufacture of incandescent mantles or filaments for use in connection with gas or electric incandescent lamps." A. J. BOULT. (Communicated by O. H. Steuer, of Germany.) Dated July 4th. *(Complete.)*

13,081. "Improvements in the construction of plates for secondary batteries." J. PITKIN. Dated July 4th.

13,085. "Means for facilitating the starting of liquid hydrocarbon engines." W. D. PRIESTMAN and S. PRIESTMAN. Dated July 4th.

13,101. "Improvements in the method of winding for dynamo-motors for balancing a three-wire system of electrical distribution." D. URQUHART. Dated July 5th.

13,133. "An improved automatic electro-magnet switch." J. H. MCLEAN. Dated July 5th.

13,203. "Improvements in electric traction and apparatus therefor." D. COOK. Dated July 6th.

13,217. "Improvements in secondary electric batteries." THE LITHANODE AND GENERAL ELECTRIC COMPANY, LIMITED, and J. T. NIBLETT. Dated July 6th.

13,218. "Improvements in plates or elements for secondary electric batteries." THE LITHANODE AND GENERAL ELECTRIC COMPANY and J. T. NIBLETT. Dated July 6th.

13,274. "Improvements in the manufacture of plates for electric accumulators." C. ROUSSEAU. Dated July 7th.

13,276. "Improvements in and relating to electric arc lamps." E. JOKL and C. HOLZAPFEL. Dated July 7th.

13,279. "Improvements in car pieces for telephones." R. SEIFFERT. Dated July 7th. *(Complete.)*

13,336. "Improvements in the electrolytical production of nickel and other metals." C. HOEPFNER. Dated July 8th.

13,339. "An improved manufacture of carbon for electrical purposes." H. H. LAKE. (Communicated by A. C. Girard and E. A. G. Street, France.) Dated July 8th.

13,340. "Improvements in and relating to electric furnaces." H. H. LAKE. (Communicated by A. C. Girard and E. A. G. Street, France.) Dated July 8th.

13,341. "Improvements in transforming electrical energy of high tension into low tension, and in apparatus therefor." R. NIEWERTH. Dated July 8th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

871. "Improvements in electric cables." H. H. LAKE. (Communicated from abroad by D. Brooks, Jun., of Philadelphia.) Dated January 15th. Consists in providing the wires with a covering composed of a double layer of tinfoil having between them an adhesive oil, the adjacent edges of each of the layers overlapping. Also consists in so insulating an electric wire or cable that the employment of an insulating material or compound in liquid, molten or other condition, is obviated. 4 claims.

1,391. "Improvements relating to the coating of articles with a new metallic alloy by electro-deposition." THE LONDON METALLURGICAL COMPANY, LIMITED, and S. O. COWPER-COLES. Dated January 23rd. Consists in depositing, by electrolysis, an alloy of cadmium and silver, or zinc cadmium and silver. 2 claims.

1,396. "An automatic electric circuit breaker." A. EICHLER. Dated January 23rd. Consists essentially of a metallic strip, preferably slightly bent at its middle part and secured at both its ends by set-screws. This strip electrically connects the terminals of the breaker, and the curvature of the same increases under the action of the heat as soon as the intensity or the potential of the current rises above the normal, the effect of which extension is to release a lever on which the metallic strip is fastened, the aforesaid lever being subsequently swung upward by the action of a spring or of a counter weight, and the circuit being thus interrupted. 3 claims.

1,484 "Improvements in and relating to secondary batteries." J. B. ENTZ and W. A. PHILLIPS. Dated January 26th. Consists simply in applying heat to the cells, preferably at the bottom, or in mechanically agitating the solution while they are being charged or discharged, thus setting up a circulation of the electrolyte. 3 claims.

1,580. "An improved electric low water alarm." S. M. MATHEWS. Dated January 26th. Consists of a float controlled by the water in the boiler, and adapted to rest on and to press a spring for making an electric circuit. 4 claims.

2,254. "Improvements in or connected with the holders of incandescent electric lamps." W. P. THOMPSON. (A communication by M. Fuss, of Berlin.) Dated February 5th. Has for its object a safety device which is easily attached to incandescent lamps, and which prevents their removal. 2 claims.

2,329. "Improvements in process and apparatus for bleaching by electrolysis." O. IMRAY. (Communicated from abroad by T. J. Montgomery, of New York.) Dated February 6th. Has for its object to provide an electrolytic process in which the electrolyte employed is sea water. 4 claims.

2,458. "Improvements in dynamo-electric generators and motors." J. G. POOL, N. W. HUBINGER, and J. E. HUBINGER. Dated February 9th. Consists in a ring armature having its wire conductors joined in an endless or closed circuit, the successive coils of which are alternated or wound around the section of the ring in opposite directions and arranged at intervals or radial spaces apart on the ring corresponding to the distances between neutral points of adjacent poles of the field magnets, the corresponding coils of successive cycles or sub series of conductors being wound in uniform precession or recession, covering a range or interval of two field spaces of opposite polarity, with commutator connections corresponding to the said sub series, whereby the active wires are extended in opposite directions under poles of opposite polarity, and thereby joined in series connection throughout the respective halves of the circuit.

2,913. "Improvements in the electro-metallurgic extraction of zinc." G. NAHNSEN. Dated February 15th Consists in the employment of an electrolyte presenting a great conductivity, containing zinc and an alkali or magnesium, and in reducing the polarisation by applying a temperature of about 130° F. 1 claim.

4,764. "Improvements in insulators for electric wires." H. H. LAKE. (Communicated from abroad by C. N. Hammond, of America.) Dated March 10th. 1. An insulator for electric wires having a straight recess or passage through the same to receive the wire, said recess being partially closed by a lip or lips. 2. An insulator for electric wires having a straight recess or passage through the same to receive the wire and permit the latter to move endwise with freedom and having a curved slot leading into the said recess or passage for the introduction of the wire, two over-hanging lips or flanges being formed on one side of the said slot and one on the other.

4,773. "Improvements in the manufacture of electrical conductors." G. F. REDFERN. (A communication from abroad by S. Bergmann, of Berlin.) Dated March 10th. Claim:—The described process for the manufacture of compound electrical conductors, consisting in alternately thrusting into each other paper tubes coated within and without with a fusible insulating material and a copper rod and tubes heated to the melting point of this insulating material, thus bringing the inner and outer insulating layers of a paper tube to the melting point, and causing intimate union of the paper tube both with the copper rod or tube lying inside it, and the copper tube lying outside it, the whole being then pushed into an iron tube heated to the melting point of the insulating material, and which is so intimately united with the outer paper tube that an electrical conductor is obtained which contains within it two or several conductors, which are entirely insulated from one another and are perfect in themselves.

4,816. "Improvements in electrical cables." W. FAIRWEATHER. (Communicated from abroad by E. F. Phillips, of America.) Dated March 11th. Consists in providing a solid and semi-rigid central foundation core, which may preferably be made of twisted or braided insulated conductors, so that the said core also shall be utilisable, to serve as a central base for outer cable conductors, although, if desired, the said foundation core may be made of solid insulating material, such as jute, rope, or paper, and in braiding over the said foundation core, and without any filling of interbraided fibrous cores or twines, two series of four conductors, the four conductors of each series being at the four quadrantal points of a circle inscribed round them; the two series having opposite helical directions of winding; the necessary distance to ensure a low capacity being maintained, and at the same time the necessary firmness being ensured by braiding the conductors with wide intermediate spaces, but solidly upon the core. It also consists in forming a number of such braided constructions, each having a central foundation core as above, into a cable, and providing them with a common external protective covering, and also by superposing a second, and, if desired, a third compound longer pitch braid over the first. 8 claims.

4,961. "Improvements in slide resistances for electrical purposes." A. MUIRHEAD. Dated March 14th. Consists in constructing the set of slides of four series of coils, three series of 11 coils each, and one series of 10 coils. 1 claim.

5,096. "Printing telegraphs." E. J. SILKMAN. Dated March 15th. The principal object of the invention is to provide a simple and effective apparatus which insures the duplication on the receiver of the character transmitted without the possibility of error. 28 claims.

6,722. "Improvements in battery plates for secondary batteries." W. W. DONALDSON and R. MACRAE. Dated April 7th. The inventors take a plate of any suitable inactive material and place it flat over the top of a cavity in a mold and over pins and apply pressure, a movable plate being down. The plate is forced into the mold and forms a tray or cup with the edges turned up the depth of the cavity in the mold above the movable plate. The pins are forced through the plate until their top or upper ends are subtantially on a level with the top of the tray or cup. The cup thus formed is then filled with active material, and allowed to stand a sufficient length of time to set, being packed around the pins, and then it is removed by forcing outward the movable plate being provided with a plurality of holes. Other plates or cups are formed and two of them are placed together and united, a diaphragm being placed between them if desired. 2 claims.

7,253. "Improvements in generating electricity and producing air in a luminous state, and in apparatus therefor." T. DUFFY. Dated April 14th. Consists mainly in a novel manner of making and breaking the magnetic circuit between the poles of a horse-shoe magnet by elastic tongues or strips of metal kept in vibratory motion by a blast or current of air under pressure, and in certain novel construction of parts and mechanism producing an improved machine or apparatus for generating electricity through the agency of a blast or current of air. There is included in the said improvements the rendering air luminous or creating a high degree of vibratory motion sufficient to produce luminosity by forcing or blowing atmospheric air through or between elastic tongues or strips of conducting metal having their tips or free ends set to vibrate in close relation to the poles of a horse-shoe magnet. 5 claims.

7,415. "Improvements in and relating to electric propulsion of vehicles and boats." M. W. DEWEY. Dated April 19th. Consists chiefly in locating in the line conductor separate coils of wire, distributed equal distances apart along the roadway, preferably beneath the same. The said coils may be arranged in any suitable manner, provided that they or their cores are in proper inductional relation to a secondary coil carried by the vehicle, and may be connected with the line circuit either in series or parallel. Said coils may all be constantly in circuit or they may be included in circuit only when the car is over them, or in suitable inductional proximity thereto. 31 claims.

8,535. "Electrical hose signalling apparatus." W. FOWLER. Dated May 5th. The inventor attaches a bell or enunciator to the hose nozzle and another to the engine at a suitable point, these bells being both located in the same circuit, which is formed by running wires from a galvanic battery or other suitable source of electricity, preferably located on the engine, along the hose, which forms their support, the circuit being so established with reference to the bells or alarm mechanism that both enunciators—that is, those at the engine and nozzle—are simultaneously sounded by pressing a button at either point, whereby the person giving the signal is assured that the apparatus is in working order. 5 claims.

8,572. "An improved galvanic element." H. BECKMANN, E. BECKMANN and J. SCHMITT. Dated May 5th. Claim:—A galvanic element, characterised by the electrolyte being a salt of the positive electrode, so that a self-acting regeneration of the electrolyte is obtained, substantially as described.

9,056. "Improvements in and relating to means for electrically giving reciprocating motion." H. S. MCKAY. Dated May 24th. Consists of two or more electro-magnetic devices which are connected with an electric circuit in such manner that a continuous current is transmitted through the magnetic devices and an armature adapted to be reciprocated by the alternate attraction of said magnetic devices without breaking the circuit. 26 claims.

9,379. "Improvements relating to the heating and working of metal bars by electricity." G. D. BURTON. Dated May 17th. Claim:—The method of heating desired portions of a bar of metal spanning the space between electrodes of opposite polarity, which consists in passing a heating current of electricity through the bar and applying to a portion of the bar between the electrodes, while the current is passing therethrough, a conductor which diminishes the resistance of the part of the bar which it bridges over and retards or prevents its being heated there, substantially as described.

9,380. "Improvements in mechanism for converting electric currents and in the method of applying the same to the working of metals." G. D. BURTON. Dated May 17th. Relates chiefly to a compound converter consisting of two single converters, which reduce the primary currents of different potential, these two converters being so arranged and connected that their secondary currents may be applied to the heating, or maintaining the heat of the same bar at different stages in the heating process. 11 Claims.

9,409. "Improvements in electro-magnets for organs and for other suitable purposes." J. J. BINNS. Dated May 18th. Claims:—1. The construction of electro-magnets having coils upon inner cores or tubes within outer tubes, fastened to sustaining or affixing plates, the coils extending to the full length of the inner cores or tubes, substantially as and for the purposes shown and described. 2. For use in connection with organs the construction of electro-magnets having coils upon inner cores or tubes within outer tubes fastened to sustaining or affixing plates, the coils extending to the full length of the inner cores or tubes, in combination with an arrangement of adjustable armature substantially as shown and described.

9,863. "Improvements in electric signalling apparatus." H. H. LAKE. (Communicated from abroad by the Electric Secret Service Company, of Broadway, New York.) Dated May 24th. Relates particularly to improvements in electric signalling mechanism, known in the art as individual call apparatus; such, for instance, as is used in telephonic, telegraphic, and analogous electric signalling systems for transmitting a particular signal to an outlying station, which will indicate to the subscriber or operator at that station, and to him alone, that he is wanted. 19 claims.